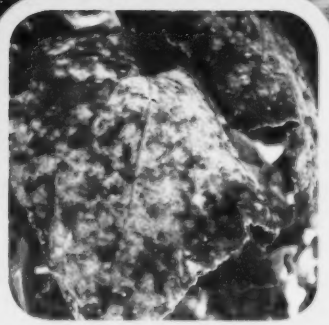
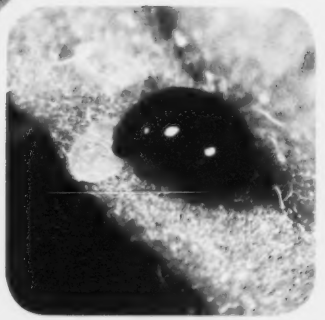




CROP PROTECTION GUIDE FOR GREENHOUSE VEGETABLES

2010–2011

Publication 835

Ministry of Agriculture,
Food and Rural Affairs

Ontario

Discard old editions of this publication. Each year the appropriate sub-committee of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication. To the best knowledge of the committee, at the time of printing, the pesticide products listed in this publication were:

- federally registered
- classified by the Ministry of the Environment (MOE).

The information in this publication is general information only. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

This publication lists a number of brand names of pesticides. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

The Pesticide Label

Consult each product label before you use a pesticide. The label provides specific information on how to use the product safely, hazards, restrictions on use, compatibility with other products, the effect of environmental conditions, etc.

The pesticide product label is a legal document. It is against the law to use the product in any other way.

Federal Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticide products for use in Canada based on following an evaluation of scientific data to ensure that the product has merit and value, and the human health and environmental risks associated with its proposed use are acceptable.

1. **Full Registration**
   Pesticide registrations are normally granted for a period of five years, subject to renewal.

2. **Conditional Registration**
   Conditional registration may be granted for a specified, limited time period, where the registrant agrees to produce additional scientific or technical information, or the pesticide is used for emergency control of a serious pest outbreak.

Maximum Residue Limits

The PMRA has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market to determine if more restrictive limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Supplemental Labels

You MUST obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- **Emergency Use Registration**
- **Minor Use Label Expansion**

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAFRA or PMRA's Pest Management Information Service.

For more information on the federal registration status check the PMRA website at *www.pmra-arla.gc.ca* or call 1-800-267-6315.

Regulation of Pesticides in Ontario

The MOE is responsible for regulating pesticide sale, use, transportation, storage and disposal in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 63/09.

All pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 63/09, which are available on the e-laws website at *www.e-laws.gov.on.ca* or by calling ServiceOntario Publications Toll-Free number: 1-800-668-9938 or 416-326-5300.

Classification of Pesticides

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the MOE, the classification of pesticide products before they can be sold or used in Ontario. Once approved by the MOE, classified products are posted on the MOE website at *www.ene.gov.on.ca*.

Certification and Licensing

Growers and Their Assistants

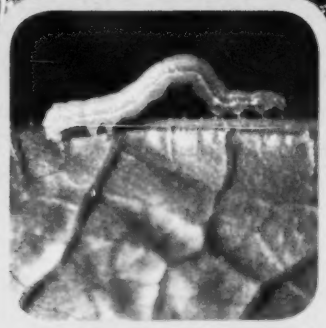
For information about certification for growers and training for assistants, check the Ontario Pesticide Education Program website: *www.opep.ca* or call 1-800-652-8573.

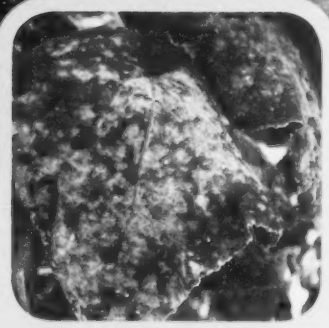
Commercial Applicators and Their Assistants

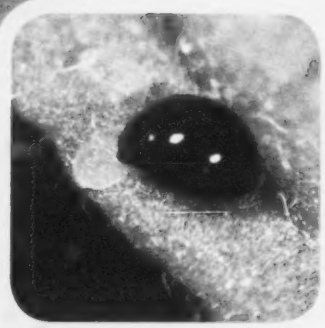
For more information about exterminator certification and licensing and technician training check the Ontario Pesticide Training & Certification website at *www.ontariopesticide.com/OPTC/default.htm* or call 1-888-620-9999 or 519-674-1575.

Cette publication est aussi disponible en français.

Bib. 303303







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Food and Rural Affairs

Ontario

Acknowledgements

The information contained in this publication is provided following review by the Greenhouse Vegetable Sub-committee under the Ontario Pest Management Services Committee, and by registrants.

Need technical and business information?

Contact the Agricultural Information Contact Centre at
1-877-424-1300
or ag.info.omafra@ontario.ca

Looking for greenhouse production information on the Internet?
Check the OMAFRA website at
www.ontario.ca/crops

This publication contains all pesticide products that have been registered to date on greenhouse vegetable crops. For more comprehensive information on pest management strategies, pest life histories and diseases and on information related to production of the major greenhouse vegetables in Ontario, see OMAFRA Publication 836, *Growing Greenhouse Vegetables in Ontario.* Information on ordering OMAFRA publications is found on the inside back cover of this book. Supplements to this publication will be posted to the OMAFRA website.

Cover Images

FRONT: Large left: Assortment of greenhouse vegetables (photo courtesy of Ontario Greenhouse Vegetables Growers)
Large right: Greenhouse tomato crop
Small left: Cabbage looper
Small centre: Powdery mildew on cucumber leaf
Small right: Predatory beetle feeding on immature whitefly

BACK: Large left: Greenhouse tomato crop
Large right: Assortment of greenhouse vegetables (photo courtesy of Ontario Greenhouse Vegetables Growers)
Small left: Terminal leaves of cucumber plant heavily infested with two-spotted spider mites
Small centre: Botrytis grey mould on node of pepper stem
Small right: Aphid

Introduction

Products Listed in This Book

This book lists products that are registered for use on greenhouse vegetable crops and have been reviewed by the registrants and the Greenhouse Vegetable Sub-committee under the Ontario Pest Management Services Committee. Products are listed according to pest for each greenhouse vegetable crop. Information within the tables is based on labels provided by registrants and is included so that growers can consider options when implementing their pest management programs. When selecting a product to use, growers should consider several factors including compatibility with beneficial insects, safety to the user, pre-harvest and re-entry intervals and resistance management.

Resistance Management Strategies

Different pesticides control pests in different ways. This is called the mode of action. Pesticides are grouped into chemical families/groups based on their mode of action. Using the same pesticide with the same mode of action season after season or several times within the same season could result in the target pest becoming resistant to the chemical family. A pest can develop resistance to one chemical family but still be very susceptible to another. Therefore, to reduce the risk of a pest developing resistance, use the following strategies:

- Avoid repeated use of pesticides from the same chemical subgroup (indicated by the IRAC and FRAC Mode of Action Group number — see Appendix D). For insecticides, rotate between chemical groups/families. Use products within one group only for the duration of one generation of the target insect before switching to another group for the following generation.
- Only use pesticides when necessary and integrate them as much as possible with other management strategies in an Integrated Pest Management (IPM) program. For example, to manage insect and mite pests, major strategies should include crop monitoring and biological control. Cultural controls such as sanitation and mass trapping should also be considered to minimize pesticide use and thereby reduce the risk of a pest developing resistance to a pesticide. To manage diseases, major strategies should include sanitation, maintaining optimum levels of moisture and nutrients in the growing media and manipulation of environmental parameters (e.g., relative humidity and temperature) to minimize conditions that favour development of disease. For further details on insect pests, mite pests and diseases, as well as IPM strategies for managing them, refer to OMAFRA Publication 836, *Growing Greenhouse Vegetables in Ontario.*
- Do not exceed the total number of applications allowed per year for each product. Do not apply the product at rates lower than the recommended rate on the label.
- Monitor recently treated pest populations for signs of resistance.
- See the pesticide label for more information on resistance management. For more information on resistance management strategies or IPM options for a specific pest, contact your local OMAFRA specialist or IPM consultant.

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1. Using Pesticides in Ontario

Read the latest product label before using a pesticide!
Review the *Grower Pesticide Safety Course Manual*. Keep detailed spray records.

Federal Registration of Pesticides

Before a pesticide can be sold or used in Ontario, it must be registered under the federal *Pest Control Products Act* (PCP Act) and be classified under the provincial *Pesticides Act*. The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticides for use in Canada following an evaluation of scientific data to ensure that the product has merit and value. It also ensures that the human health and environmental risks associated with its proposed use are acceptable.

The PMRA re-evaluates registered pesticides to determine whether today's health and environmental protection standards are still met when following the label directions. Outcomes of a re-evaluation can be:

- no change in the registration
- label amendments (i.e., changes to personal protective equipment requirements, re-entry intervals and buffer zones)
- modifications to existing maximum residue limits (MRLs)
- elimination or phasing-out of certain uses or formulations
- no further acceptance of the registration

The pesticide label is a legal document. It prescribes how the pesticide can be legally used. Off-label use is prohibited. It is against the law to use the pesticide in any other way or on any other crop or pest than as specified on the label. Labels for all registered pesticides are under Label Search on the PMRA website at www.pmra-arla.gc.ca. Ensure you have the most current label and are aware of any re-evaluation decisions.

Regulation of Pesticides in Ontario

The Ministry of the Environment (MOE) is responsible for regulating the sale, use, transportation, storage and disposal of pesticides in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 63/09. All pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 63/09, which are available on the e-laws website at www.e-laws.gov.on.ca or by calling Service Ontario at 1-800-668-9938 or 416-326-5300.

Classification of Pesticides

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the MOE the classification of pesticide products before they can be sold or used in Ontario. Pesticide products are classified on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration, usage, federal class and registration status. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario. Once approved by the MOE, classified products are posted on the MOE website at www.ene.gov.on.ca.

The Ontario pesticide classification system changed from 6 Schedules to 11 Classes (Regulation 63/09).

Certification and Licensing

Growers and Their Assistants

For information about certification for growers and training for assistants to growers, visit the Ontario Pesticide Education Program website at www.opep.ca or call 1-800-652-8573.

Commercial Applicators (Exterminators) and Their Assisting Technicians

For more information about exterminator licensing and technician training, visit the Ontario Pesticide Training & Certification website at www.ontariopesticide.com/OPTC/default.htm or call 1-888-620-9999 or 519-674-1575.

For more information about pesticide regulations, certification and licensing see:

- Inside front cover of this publication
- Pest Management Regulatory Agency (PMRA) website: www.pmra-arla.gc.ca
- PMRA Pest Management Information Service: 1-800-267-6315 (from within Canada) or 1-613-736-3799 (from outside Canada)
- Ontario Ministry of the Environment (MOE) website: www.ene.gov.on.ca
- Regional MOE Pesticides Specialist (See Appendix E. Ontario Ministry of the Environment — Regional Contact Information)
- Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) website: www.ontario.ca/omafra
- Ontario Pesticide Education Program (Ridgetown College) website: www.opep.ca
- Ontario Pesticide Training & Certification website: www.ontariopesticide.com/OPTC/default.htm

Pesticide Application Information

When you decide to use a pesticide, choose the most appropriate formulation and application method for your situation. Use only a properly calibrated sprayer. Choose less toxic alternatives when possible. Take all possible precautions to prevent the exposure of people and non-target organisms to the pesticide. Read the most current pesticide label thoroughly before application. The label provides important information, such as:

- directions for use (rates of application, crops it can be used on, target pests, crop rotation restrictions, total number of applications, droplet size/nozzle type, application equipment, timing and ideal weather conditions)
- required personal protective equipment
- health hazards and toxicity
- re-entry intervals
- buffer zones
- special warnings
- steps to be taken in case of an accident
- disposal

For more information on hazards, consult the Material Safety Data Sheet (MSDS) or contact the manufacturer.

Re-Entry Intervals

The re-entry interval, also referred to as Restricted Entry Interval (REI), is the period of time following a pesticide application during which workers must not enter the treatment area without wearing protective clothing and personal protective equipment. This allows any pesticide residue and vapours to dissipate from the treatment location (e.g., field), preventing the possibility of inadvertent pesticide exposure.

The PMRA reviews each pesticide to determine whether the label should include a specific re-entry interval. If the re-entry interval is not stated on the label, assume that the spray solution must be dry before re-entry can occur. Some pesticides have labels that carry a warning about working in treated crops. Follow the label recommendations.

Days to Harvest for Food Crops (Preharvest Intervals, Pregrazing and Feeding Intervals)

These intervals state the minimum time that must pass between the last pesticide application and the harvesting of the crop, or the grazing or cutting of the crop for livestock feed. If you harvest a crop before the preharvest interval (PHI) has passed, there may be pesticide residues in excess of the maximum residue limits (MRLs) set by PMRA.

To avoid exceeding the maximum residue limits, always follow the directions on the label.

Buffer Zones

Buffer zones are areas left untreated to protect an adjacent sensitive area, such as sensitive terrestrial and aquatic habitats, well heads, non-target crops and areas where children play.

Leave a suitable buffer zone between the treatment area and adjacent sensitive areas. Buffer zones may vary depending on the method of application (i.e., aerial, field boom, hand-held sprayer). Some pesticide labels specify buffer zone requirements. Check the pesticide label for the type of buffer zone required.

Sensitive terrestrial habitats include hedgerows, grasslands, shelterbelts, windbreaks, forested areas, woodlots, vegetative strips, etc.

Sensitive aquatic habitats include lakes, reservoirs, streams, creeks, ditches, marshes, wetlands, ponds, commercial fish ponds, etc.

Setback Distances for Water Bodies

It is an offence under the federal *Fisheries Act* to introduce into water any material that may be harmful to fish or fish habitat. To protect these waters, applicators must determine a suitable setback distance between the area to be protected and the area where pesticide treatments are planned (if one is not specified on the pesticide label). The protected area includes the water body as well as adjacent riparian (riverbank) areas that contribute to fish food and habitat.

Protect the Environment

Protect Water Sources

According to the British Crop Protection Council (BCPC), between 40 and 70% of surface water pesticide contamination comes from mixing and filling areas.

You should load or mix pesticides on impermeable surfaces that are safely away from watercourses or environmentally sensitive areas. Drainage and run-off should be collected and disposed of safely (*Your Guide to Using Pesticides*, BCPC 2007).

Clean your spray equipment away from wells, ponds, streams and ditches. Apply the diluted rinse water (usually at a ratio of 10 to 1) to the treatment area (crop) but do not exceed the pesticide rate recommended on the label.

Do not make a direct connection between any water supply (e.g., public supply, wells, watercourse or pond) and a spray tank. Use an anti-backflow device or intermediate system to prevent back-siphoning that could contaminate the water supply.

Immediately contain and clean up any spills to prevent contamination to water sources.

Check the pesticide label for specific instructions on water source protection.

For more information on protecting water sources, see:

- OMAFRA Factsheet *Groundwater — An Important Rural Resource: Protecting the Quality of Groundwater Supplies,* Order No. 06-115
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices — Pesticide Storage, Handling and Application,* Order No. BMP13

Prevent Bee Poisoning

It is important to protect bees when spraying insecticides. Honeybees, as well as other bees and insects, are important pollinators of crops. Many crops also offer bees sources of nectar for honey production.

Read each pesticide label for specific precautions regarding bees. Choose less toxic alternatives when possible. Most organophosphate and carbamate insecticides are highly toxic to bees.

Advise local beekeepers before you apply a pesticide, so that they may take additional precautions to protect their bees. Contact the Provincial Apiarist at 1-888-466-2372, ext. 63595, for a list of the beekeepers in your area. Follow guidelines regarding spray timing to prevent unnecessary poisonings. For more information on preventing bee poisoning, see the "apiculture" section of the OMAFRA website at www.ontario.ca/crops.

Manage Drift

- Do not spray when wind speeds are high or gusty. These conditions will favour spray drift. Check pesticide labels for allowable wind speeds for spraying applications. Some labels may not provide this specific information. Constantly monitor wind conditions during spraying using a good-quality wind meter. Record the wind speed and direction. As wind conditions change, you may need to make adjustments to further reduce the drift potential, such as adjusting water volume upwards, minimizing nozzle-to-target distance, changing nozzle technology or changing fields because of surrounding influences, or stop spraying until conditions improve.
- Do not spray during periods of dead calm. Periods of dead calm usually occur in early morning or late evening, at which time the temperature is usually cooler and the relative humidity is typically higher. The combination of these factors can result in drift-sized droplets staying in the field. When the wind picks up, these spray droplets can move away from the target area, possibly causing injury to adjacent non-target areas.
- Use the recommended sprayer output (water volume).
- Use a nozzle that will produce the appropriate droplet size if specified on the pesticide label.
- Use the most appropriate nozzle for the type of application. Where practical, use air induction/venturi nozzles, which significantly reduce drift when compared to conventional nozzles.
- Check the height of the boom to the target, and minimize the distance as much as possible while still maintaining spray uniformity.
- Follow buffer zone requirements for the protection of adjacent sensitive areas as outlined on the pesticide label.
- Use spray plume protection where practical or available (hoods, shrouds, screens and air curtains).
- Use drift-reducing adjuvants in the spray tank as directed on the label.
- Use wick weeders instead of spraying, when possible.
- Use non-volatile pesticide formulations or products.

For more information about spray drift, see:

- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices — Pesticide Storage, Handling and Application,* Order No. BMP13
- Ontario Pesticide Education Program (Ridgetown College) videos *How to Manage Spray Drift* and *Spray Drift Reduction Through Air Induction,* available at www.opep.ca/Educational/EducationalMaterials.htm

Pesticide Disposal

Empty Pesticide Containers

Never reuse empty containers. Puncture the cleaned empty containers to make them unusable.

The Ontario Empty Pesticide Container Recycling Program is available to growers and commercial applicators. Through this program, you can return cleaned and triple-rinsed plastic or metal pesticide containers (up to 23 L for plastic and 20 L for metal) to pesticide container depots located throughout the province. Remove the paper booklet from the pesticide container before recycling. To locate the closest pesticide container recycling depot, call the Ontario Pesticide Education Program at 1-800-652-8573 or your local dealer or municipality, or visit the CropLife Canada website at www.croplife.ca.

Surplus Spray Mix

The best way to dispose of any excess spray mix is to find other fields that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that crop.

If you cannot find another field to spray, dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. The diluted solution can be safely applied to the original treated area as long as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest or surplus spray mix disposal.

Never re-spray the treated field with undiluted spray mix. Spraying an area twice will double the recommended pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

Surplus Pesticides in Storage

Be sure to safely dispose of pesticides that you do not need or cannot use. Options for proper disposal include:

- Contact the supplier. It is sometimes possible to return unused pesticide if it is still in its original, unopened container.
- Hire a waste hauler who is licensed under Part V of the *Environmental Protection Act* to carry hazardous wastes. Look in the Yellow Pages of your telephone directory under Liquid Waste Removal.
- Check your local paper or visit the CropLife Canada website (www.croplife.ca) for upcoming Obsolete Pesticide Collection Days.
- Contact your municipality to see if any waste collection days are scheduled, and verify whether quantities of agricultural pesticides will be accepted.

Storing Pesticides

Ontario's *Pesticides Act* and Regulation 63/09 provide details on storage requirements for storage facilities. The storage requirements that must be followed are dependent on which classes of pesticides you store.

For more information about storing pesticides, see:

- OMAFRA Factsheet *Farm Pesticide Storage Facility,* Order No. 07-059
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices — Pesticide Storage, Handling and Application,* Order No. BMP13
- Ontario Pesticide Education Program (Ridgetown College) *Grower Pesticide Safety Course Manual,* available at www.opep.ca/Educational/ EducationalMaterials.htm

Pesticide Spills

If a pesticide spill causes, or is likely to cause, an adverse effect that is greater than that which would result from the proper use of the pesticide, you must notify the **Ministry of the Environment Spills Action Centre** at 1-800-268-6060 (24 hours a day, 7 days a week) and your municipality.

A spill is defined as a discharge of pollutant that is abnormal in quality or quantity, from or out of a structure, vehicle, or other container into the environment. An incident such as an overturned pesticide sprayer that results in the loss of the spray solution to the environment is an example of a spill. A pesticide container that ruptures and leaks its contents is another example of a spill. The discharge or spraying of a pesticide in an unapproved area, commonly referred to as an overspray, is also considered a spill.

Before you begin to clean up a spill of any nature, remember to protect yourself against pesticide exposure. Wear the proper protective clothing and personal protective equipment. If the spill occurs inside an enclosed area (e.g., a pesticide storage area or a vehicle during transport), ventilate the area first. Once you have protected and/or removed yourself and other persons or animals from the spill site, take additional measures to stop the spill at the source and prevent it from spreading and/or contaminating watercourses. Specific precautions, emergency contact information and first aid procedures may be found on the label.

For minor spills, it may be possible to remediate the problem:

- **For a liquid spill** — Cover the spill with a thick layer of absorbent material such as kitty litter, vermiculite or dry soil. Sweep or shovel the material into a waste drum and dispose of the contents as you would a hazardous waste.
- **For a dust, granular or powder spill** — Sweep or shovel the material into a waste drum and dispose of the contents as you would a hazardous waste.

For major spills, it is essential to stop the spill from spreading. The cleanup guidelines above may not be appropriate for all spill situations. Once you have contained the spill, follow directions from the manufacturer and regulatory authorities on cleaning the contaminated area.

For information on preventing spills, see:

- OMAFRA Factsheet *Ways to Avoid Pesticide Spills,* Order No. 96-025
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices — Pesticide Storage, Handling and Application,* Order No. BMP13
- Ontario Pesticide Education Program (Ridgetown College) *Grower Pesticide Safety Course Manual,* available at www.opep.ca/Educational/ EducationalMaterials.htm

For pesticide poisonings and pesticide injuries call:

Poison Information Centre

1-800-268-9017

(TTY) 1-877-750-2233

For more information, see Emergency and First Aid Procedures for Pesticide Poisoning on the inside back cover.

2. Safe Use of Pesticides

Human Health

Risks of Pesticide Use

Each time a pesticide is handled, there is some risk. The amount of risk depends on two things: the toxicity of that pesticide and the degree of exposure to it.

Toxicity is a measure of how harmful or poisonous the pesticide is. There are two types of toxicity:

- **Acute toxicity** — the toxic response that results from a single exposure to the pesticide. The symbols and words on the front panel of a pesticide label give information about the acute toxicity (see Table 2–1, *Label Hazard Symbols and Words*, on page 8).

Lethal dose 50% (LD50) is a measure of acute toxicity. It is the dose (in mg of product per kg of body weight) that will kill 50% of test animals (usually female rats) within a stated period of time (24 hours to 7 days). This is commonly measured as the acute oral LD_{50}, which refers to the chemical ingested through the mouth or nose. Dermal LD_{50} figures, or skin penetration, are also available. The oral LD_{50} of a pesticide is listed in Table 3–1, *Insecticide and Miticide Toxicity*, and Table 3–2, *Fungicide Toxicity*.

The lower the LD_{50} figure, the more toxic the product is to humans.

Examples of products with a high acute toxicity (low LD_{50}) include:

Common (Active) Name	Trade Name
dichlorvos	DDVP
endosulfan	Thionex

- **Chronic toxicity** — the toxic response that results from repeated exposure to small doses of a pesticide over a longer period of time. These toxic effects may not appear for months or years after exposure to the pesticide. The symbols on the label do not give information about the chronic toxicity of the product. Use protective clothing and equipment to help reduce exposure and risk of chronic effects.
- **Exposure** refers to contact with the pesticide. Workers can be exposed to the pesticide in three ways:
- **Dermal exposure** occurs through the skin or eyes. The amount and rate of pesticide that may be absorbed depends on several things, including:
  - Skin condition at time of exposure: If the skin is moist, or if a rash, broken skin or scratches are present, pesticides will be absorbed more easily.
  - Part of the body that is exposed: Eyes, genital area, scalp and ear canals absorb pesticides at a higher rate than hands or arms. Eyes are particularly vulnerable because the tissues are very absorbent.
- **Respiratory exposure (inhalation)** occurs when small spray particles, dust, gases or vapours are inhaled.
- **Oral exposure** occurs when a pesticide enters the mouth or is swallowed.

Cholinesterase Blood Tests

Organophosphorus and carbamate pesticides can affect the human nervous system. These pesticides can reduce the levels of the enzyme acetyl cholinesterase in the serum and red blood cells. The body uses this enzyme to transmit messages through the nervous system. If cholinesterase levels fall, individuals experience symptoms such as trembling, twitching, blurred vision, salivation, sweating, breathing difficulties and frequent bowel movements and urination.

People who use any organophosphorus or carbamate pesticides on a routine basis should have regular cholinesterase blood tests. A family doctor can arrange these tests, which are covered by the Ontario Health Insurance Plan (OHIP). Workers should have their first test before beginning to handle these pesticides to determine their normal (baseline) cholinesterase level.

During the spray season, workers who spray organophosphorus or carbamate insecticides regularly for several weeks should have a cholinesterase blood test every 7 to 10 days. If the worker's cholinesterase level drops to less than half of the baseline level, the worker is showing signs of pesticide poisoning and must avoid exposure to these pesticides until cholinesterase levels return to normal.

Examples of organophosphorus or carbamate insecticides

Common (Active) Name	Trade Name
dichlorvos	DDVP
malathion	Malathion
naled	Dibrom
endosulfan	Thionex

Read and Follow Pesticide Label Information

Know the Hazard Symbols and Signal Words

Four important symbols and words show the potential hazards of pesticides.

Table 2–1. Label Hazard Symbols and Signal Words

Hazard Symbol	Signal Word
	Poison
	Corrosive
	Flammable
	Explosive

The hazard symbol always appears inside one of the shapes shown below. The shape and its signal word together indicate the degree of hazard of the pesticide. The greater the number of sides of the shape, the more hazardous the product.

Table 2–2. Degree of Hazard, Warning Symbol and Signal Word

Degree of Hazard	Warning Symbol	Signal Word
Triangular shape (3 sides) means low hazard		Caution
Diamond shape (4 sides) means moderate hazard		Warning
Octagonal shape (8 sides) means high hazard		Danger

Learn these symbols and words — they could save your life!

Check the label for special warnings about eye hazards and skin hazards.

Re-entry Periods

The re-entry period is the minimum amount of time that must pass between the time the pesticide was applied and the time workers can go into the treated area without wearing personal protective equipment. If workers enter treated areas without wearing protective equipment too soon after pesticides have been applied, they may experience poisoning from handling treated plants or inhaling pesticide vapours.

Some pesticides have labels that carry a warning about working in treated crops. Follow the label recommendations. The product label is always the best source for this information. Otherwise, take note of the re-entry periods listed for products in the tables in chapters 4–8, which show specific minimum intervals between applying the greenhouse-registered pesticide and working in the treated crop without protective equipment.

First Aid

If an accident occurs:

1. Rescuers should always protect themselves from injury. Protective clothing and equipment should always be worn before entering a contaminated area or handling a contaminated victim.

Symptoms of Pesticide Poisoning

Mild Symptoms

Headache; fatigue (tired feeling); loss of appetite; dizziness; weakness; nervousness; nausea; perspiration; diarrhoea; loss of weight; thirst; moodiness; irritation of the skin, eyes, nose or throat.

Moderate Symptoms

Nausea, trembling, loss of muscular co-ordination, excessive saliva, blurred vision, constricted throat or chest, laboured breathing, flushed or yellow skin, abdominal cramps, vomiting, diarrhoea, mental confusion, perspiration, rapid pulse, cough.

Severe Symptoms

Vomiting, loss of reflexes, inability to breathe or increased breathing rate, muscle twitching, tiny pupils, convulsions, unconsciousness, thirst, fever.

(Source: *Grower Pesticide Safety Course Manual,* University of Guelph Ridgetown Campus. Available online at www.opep.ca.)

If symptoms occur during or shortly after handling a pesticide, go to a hospital. Take the pesticide label, Material Data Safety Sheet (MSDS) or pesticide container. Do not transport the container in the passenger compartment. See the Emergency First Aid Procedures for Pesticide Poisoning on the inside back cover.

2. Check to see if the victim is breathing.

   If the victim is not breathing:

   - Straighten the victim's airway and check for breaths.
   - If the victim does not begin to breathe, perform artificial respiration until the victim begins to breathe independently.
   - Avoid becoming contaminated, especially if the victim has pesticide or vomit around the face or mouth. Use a face shield airway with a one-way valve. Do not breathe the exhaled air from the victim.
   - If the victim's pulse disappears, perform CPR if qualified to do so.

   If the victim is breathing, but unconscious:

   - Place the victim in the recovery position (on the side with the head turned slightly down). If the victim vomits, try to keep the airway clear.

3. Stop the exposure to the pesticide. Move the victim away from the contaminated area. Remove all contaminated clothing from the victim. Use soap and water to wash any skin exposed to the pesticide.

4. Check the four basic facts:
   - What? Identify the pesticide. Look for the label, container or leftover pesticide.
   - How much? How much product was the victim exposed to?
   - Where? Did the pesticide enter the body through the mouth, skin, eyes or lungs?
   - When? How much time has passed since the victim was exposed to the pesticide, and how long was the exposure? Were the symptoms immediate or did the poisoning occur as a result of using the pesticide over a longer period of time?

Don't waste time.
If you can't answer these questions quickly, be ready to tell emergency personnel whatever you can.

5. Call an ambulance or the poison information centre.
6. Start the first aid treatment appropriate for the contaminant and route of entry. First aid instructions can be found on most pesticide labels.
7. Make sure the patient gets medical attention. First aid is not a substitute for professional medical help.

General Precautions When Using Pesticides

Always read the label:

- before buying a pesticide
- before using a pesticide
- before storing or disposing of a pesticide

Always keep records of pesticide use.

Learn about the health hazards and toxic properties of the pesticide being used. Consult the product label, Material Safety Data Sheets (MSDS) or manufacturer for this information. Check the company's website for MSDS information.

Protection When Using Pesticides

Tell someone where the work is taking place, what pesticides are being handled and how long the job is expected to take.

Post emergency numbers, including the numbers for the Poison Information Centre and Spills Action Centre, near all telephones.

Keep a list of the names and the *Pest Control Products (PCP) Act* Registration Numbers of all the pesticides handled. It's a good idea to

keep a file of the pesticide label booklets for all the products used. Ensure that co-workers and family members know where to find this list or file in case of an accident.

Have plenty of clean water, soap and paper towels — and an extra set of gloves and coveralls — nearby at all times in case a pesticide contaminates clothing or skin.

Wear the correct protective clothing and equipment and be sure that all items are clean and in good repair before wearing or using them.

Never smoke, chew tobacco, eat or drink when handling pesticides. Never carry tobacco or food in clothes; never leave tobacco, food or beverages in areas where pesticides are handled or stored.

Change clothes and wash hands and face before eating, drinking or smoking.

Wash hands before using the toilet, as well as after. The skin in the groin area absorbs pesticides very easily.

Protective Clothing and Equipment

Choose and wear the appropriate protective clothing and equipment. Make sure protective clothing and equipment fit properly and are clean, in good repair and in working condition. The protective clothing and equipment workers should wear depends on:

- **The pesticide being used** — read the precautions section of the label to know what is required.
- **The job being done** — for example, use more protection when handling concentrated pesticide or when mixing and loading a sprayer.
- **The type of application** — enclosed space or air-blast sprayer applications made with open tractors require more equipment.

All persons who work with pesticides need their own set of protective clothing and equipment. Consult the product label to find out what protective clothing is required.

For all pesticides, always wear:

- A water-repellent hat, such as a hard hat or waterproof rain hat
  - Sometimes the entire head and neck must be protected: for example, if applying pesticides in a greenhouse, applying dusty formulations or using an air-blast sprayer. In these situations, wear a hood or hat that protects the ear canals. Do not wear baseball-style or other cloth hats, which absorb pesticides and are not safe.
- Long pants and a long-sleeved shirt or coveralls
  - Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Disposable coveralls should be designated for pesticide use.
  - Water-resistant coveralls are preferred because cotton, denim and cotton/polyester pants cling to the skin if they get wet, which increases the risk of dermal exposure.
- Chemical-resistant gloves (unlined)
  - Use neoprene, nitrile or PVC gloves, unless the label states otherwise. Do not wear rubber gloves, because many pesticides can break down the rubber material. Fold up the cuffs of the gloves and wear the gloves tucked under the shirt or jacket sleeves.
- Chemical-resistant boots (unlined)
  - Wear pant legs over boots to prevent pesticide from running down inside the boots.

Read the label. It will describe what extra protective clothing and equipment to wear.

For some pesticides, workers should also wear:

- Goggles
  - Use safety goggles with indirect vents so that splashes do not enter the eye. Regular eyeglasses do not provide complete protection. Never wear contact lenses when handling pesticides.
- Face shield
- Chemical-resistant apron

- Respirator
  - A respirator is a unit that covers the mouth and nose to prevent spray droplets, small particles and vapours from entering the lungs. A dust mask is not a substitute for a pesticide respirator. Respirators and replacement cartridges should be NIOSH/MSHA approved. Use cartridges and pre-filters that protect against organic vapours. For more information about respirators, see the *Grower Pesticide Safety Course Manual*, Ridgetown College, University of Guelph.

For fumigants:

- When handling methyl bromide, do not wear gloves because they will trap gas next to the skin. Wear a full-face respirator with organic vapour canister or positive-pressure breathing apparatus. Some methyl bromide products require, by label, that self-contained breathing apparatus be worn at all times while using the product.
- When handling aluminum phosphide, use cotton gloves and wear a NIOSH/MSHA-approved full-face mask respirator with an acid-gas canister. Note: always check the label to find the appropriate safety equipment requirements.

When Working in Enclosed Areas

Canister Respirators

Canister gas masks are effective for protection against certain harmful gases, vapours and particulate matter. They are generally suitable for ventilated areas where conditions don't change rapidly. They should never be used in confined spaces where oxygen deficiency or high gas concentrations may occur.

Self-Contained Breathing Apparatus

Air-purifying devices do not work in confined spaces where gas concentrations are unusually high. The lack of oxygen can prove fatal. Under these conditions, use an air supply provided by a self-contained breathing apparatus (e.g., Scott Air Pack).

Substances that produce hydrogen cyanide, methyl bromide, chloropicrin or phosphine can produce high gas concentrations and reduce oxygen levels. A similar situation is caused by the use of smoke generators and foggers that use highly toxic pesticides and certain volatile sprays.

Other Protective Clothing

Wear other protective clothing in keeping with the requirements listed on the pesticide label.

Working Conditions

Always check and follow the label for appropriate safety equipment requirements. Use the recommendations below as a guide only.

- Use canister respirators when the surrounding air contains low concentrations of toxic gases, vapours or particulate matter derived from soil-drench, granular, dust or foliar spray applications. Pesticides applied in this manner usually have moderate to low toxicity.
- Use a self-contained breathing apparatus (e.g., Scott Air Pack) when applying highly toxic pesticides. Pesticides can produce high concentrations of toxic gases, vapours or particulate matter, as well as reduce oxygen levels, especially in an enclosed space (e.g., when fumigating grain).
- Read the product label for recommendations and legal requirements. A list of safety supply companies can be found in Table 2–2, *Ontario Suppliers of Protective Clothing and Equipment*, on page 13.

Safety Equipment Suppliers

Read the label for safety equipment recommendations and requirements. Protective clothing and equipment can be purchased from the suppliers listed in Table 2–3.

TABLE 2–3. Ontario Suppliers of Protective Clothing and Equipment

3-M Canada Inc.	Occupational Health and Environmental Safety Box 5757 London, ON N6A 4T1 www.3m.ca	Tel: 519-451-2500 Toll-free: 1-800-364-3577 Fax: 519-452-6720 Orders: 1-809-263-3489 OHS: 519-452-4600
Acklands Grainger	90 West Beaver Creek Road Richmond Hill, ON L4B 1E7 www.acklandsgrainger.com	Tel: 905-731-5516 Toll-free: 1-800-668-8989 Fax: 1-877-269-5044
Aearo Canada	6889 Rexwood Road Mississauga, ON L4V 1R2 www.aearo.com	Tel: 905-795-0700 Toll-free: 1-800-387-4304 Fax: 905-564-5250
DuPont Personal Protection	45 Dalkeith Drive Brantford, ON N3P 1M1 www.dupont.ca	Tel: 519-753-9306 Toll-free: 1-800-387-9326 Fax: 519-752-2161
HAMISCO	3392 Wonderland Road London, ON N6L 1A8 www.hamisco.com	Tel: 519-652-9800 Toll-free: 1-800-668-9800 Fax: 519-652-9661
Huron Tractor	305 Main Street North Exeter, ON N0M 1S3 www.hurontractor.com	Tel: 519-235-1115 Fax: 519-235-1939
Levitt-Safety Limited	2872 Bristol Circle Oakville, ON L6H 5T5 www.levitt-safety.com	Tel: 905-829-3299 Toll-free: 1-800-268-6196 Fax: 905-829-2919
MGS Horticultural Inc.	50 Hazelton Street Leamington, ON N8H 1B8 www.mgshort.com	Tel: 519-326-9037 Fax: 519-326-5861
Mitt & Robe Co.	751 Norfolk Street North Simcoe, ON N3Y 3R6 www.mittrobe.ca	Tel: 519-428-4050 Toll-free: 1-877-893-6565 Fax: 519-428-5142
MSA Canada Inc.	5535 Eglinton Avenue West Unit 222 Toronto, ON M9C 5K5 www.msanet.com	Tel: 416-620-4225 Toll-free: 1-800-267-0672 Fax: 416-620-9697
Plant Products Co. Ltd.	314 Orenda Road East Brampton, ON L6T 1G1 www.plantprod.com	Tel: 905-793-7000 Toll-free: 1-800-387-2449 Fax: 905-793-9157
Safety Express	4190 Sladeview Crescent Units 1 and 2 Mississauga, ON L5L 0A1 www.safetyexpress.com	Tel: 905-608-0111 Toll-free: 1-800-465-3898 Fax: 905-608-0091
The St. George Company (Suppliers of Kasco Helmets)	20 Consolidated Drive P.O. Box 430 Paris, ON N3L 3T5 www.thestgeorgeco.com	Tel: 519-442-2046 Toll-free: 1-800-461-4299 Fax: 519-442-7191
Sun Parlour Greenhouse Growers Cooperative Ltd.	230 Essex Road 31 Leamington, ON N8H 3W2 www.sunparlourgrower.com	Tel: 519-326-8681 Fax: 519-326-3413

Care of Protective Clothing and Equipment

After completing the spray operation, clean all protective clothing and equipment.

Never let children, pets or livestock come in contact with contaminated clothing or equipment. Also ensure that they cannot come into contact with the puddles of water that result when cleaning equipment.

Wash gloves with soap and water and then leave them on while removing other protective clothing and equipment.

Always remove protective clothing and equipment outdoors. If a granular pesticide was used, shake the clothing outdoors in a safe place. Be sure to empty pockets and cuffs.

Dispose of clothing that has been contaminated by spills of highly toxic or concentrated pesticide. Place contaminated clothing in a plastic bag and take it to a landfill site.

Continue to wear gloves while washing protective equipment. It is best to wash equipment outdoors. If the work area does not have a cleanup area outside, designate specific buckets just for equipment cleanup. Mark them and keep them in a designated place. Wash the inside and outside of goggles, hats, boots and any water-repellent clothing in warm soapy water, then rinse them well and let them air-dry.

Respirators

Remove the cartridges and prefilters from the respirator.

Discard cartridges, canisters and filter pads at the interval set by the manufacturer or earlier if breathing becomes difficult or a pesticide taste or odour is noticed.

Record the date the cartridge is first used.

Remove cartridges and filter pads from the face piece and store them in clean, sealed plastic bags.

Wash the face piece in warm soapy water, rinse it thoroughly and dry it in a well-ventilated area. Air-drying prevents damage to the inlet and outlet valves.

Never use alcohol or other solvents for cleaning because they will damage the rubber and plastic.

Rubber, Vinyl or Plastic Boots and Gloves

To avoid contact with pesticides, wash the outside of boots and gloves with detergent and water before taking them off.

After removing boots and gloves, wash them inside and out with detergent and water, rinse them thoroughly and dry them in a well-ventilated area.

How to Wash Clothes Used for Spraying

Never mix spray clothing with household laundry. All clothing used for spraying must be stored and washed separately from other clothing. Wash spray clothing after each use. Remember to use chemical-resistant gloves to handle pesticide-contaminated clothing.

Presoak clothing before washing. Use one of three methods:

- hose off garments outdoors
- soak them in a separate tub or pail
- use the pre-wash cycle in an automatic washer

Use hot water, a heavy-duty detergent and the highest water level and the longest cycle the washing machine offers. Follow the instructions that came with the machine for washing heavily soiled clothing.

Wash clothing twice.

After washing it, hang it outside (preferably in bright sunlight) until it is completely dry. Do not use a clothes dryer.

Clean the washing machine. Run the washing machine through one complete cycle using only detergent and hot water (no clothing). After laundering, place clean clothing in a plastic bag and keep them separate from other clothing.

Personal Hygiene

Always wash hands before eating, drinking or smoking.

When finished for the day, take a bath or shower as soon as possible. The longer a pesticide remains on the skin, the greater the risk that it will be absorbed into the body.

Wash hair and scrub under fingernails. Shower with a lot of soap and water.

Always change into clean clothes.

Wear clean work clothes every day. A small spill on the previous day's clothes may seem unimportant, but wearing the same clothing again without washing it prolongs exposure and increases risk.

3. Pesticide Toxicity and Activity

The LD_{50} of a pesticide listed in Table 3–1, *Insecticide and Miticide Toxicity* and Table 3–2, *Fungicide Toxicity* is a measure of its relative toxicity. The LD_{50} is the amount of product in milligrams used per kilogram of test animal (usually female rats) that kills 50% of the test animals. This is commonly measured as the acute oral LD_{50}, which refers to the chemical ingested through the mouth or nose. Dermal LD_{50} figures, which refer to chemical penetration through the skin, are also available. The lower the LD_{50} figure, the more toxic the product is to humans.

Note: Many pesticides with low acute toxicity cause long-term effects in laboratory animals. Users are therefore warned that even pesticides with high LD_{50} values could be detrimental to human health. Reduce exposure to all pesticides to a minimum by wearing protective clothing, including latex gloves, goggles and long-sleeved shirts. See Chapter 2 for more details.

Read every product label to ensure that it is used properly and safely.

Table 3–1. Insecticide and Miticide Toxicity

Common Name	Trade Name	Oral LD_{50} (mg product/kg body weight)*
Abamectin	Avid 1.9 % EC	300
Acetamiprid	Tristar 70 WSP	1,064
Bacillus thuringiensis	BioProtec, DiPel, Foray, Thuricide, Vectobac	>5,000
Beauveria bassiana	Botanigard ES, Botanigard WP	>5,000
Bifenazate	Floramite SC	>5,000
Cyromazine	Citation 75WP	>4,460
Diazinon	Diazinon 500 EC	1,600
Dichlorvos	DDVP 20% EC	56
Endosulfan	Thionex 50W	41
Endosulfan	Thionex EC	45
Fenbutatin oxide	Vendex 50 WP	>5,000
Imidacloprid	Intercept 60 WP	1,858
Lambda-cyhalothrin	Matador 120 EC	93
Malathion	Malathion 25W	1,375
Naled	Dibrom	235
Permethrin	Ambush 50 EC	2,280
Permethrin	Pounce 384 EC	1,030
Pymetrozine	Endeavor 50WG	>5,000
Pyridaben	Dyno-Mite 75 WP	1,930
Pyriproxyfen	Distance	>3,773
Spiromesifen	Forbid 240 SC	>2,000
Tebufenozide	Confirm 240F	>5,000
Tridecenyl acetate	3M Sprayable Pheromone for Mating Disruption of Tomato Pinworm	>5,000

* *Figures obtained from Material Safety Data Sheets for each individual product.*

Table 3–2. Fungicide Toxicity

Common Name	Trade Name	Oral LD_{50} (mg/kg)*
Bacillus subtilis	Rhapsody	>5,000
Boscalid + Pyraclostrobin	Pristine	>1,490
Captan	Maestro, Supra Captan	>5,000
Copper oxychloride	Fixed Copper	1,600
Dicloran	Botran 75W	>4,640
Fenhexamid	Decree	>2,000
Gliocladium catenulatum	Prestop	>2,000
Iprodione	Rovral 50WP	>2,000
Mancozeb	Manzate ProStick	>5,000
Mandipropamid	Revus	>5,000
Metalaxyl-M	Ridomil Gold	1,172
Myclobutanil	Nova 40W	3,129
Potassium bicarbonate	Milstop	2,700
Propamocarb hydrochloride	Previcur N	2,000
Pyrimethanil	Scala	>5,000
Streptomyces griseoviridis	Mycostop	>5,000
Streptomyces lydicus	Actinovate	No toxicity reported
Sulphur	Microscopic Sulphur	>5,000
Trichoderma harzianum	RootShield	Active ingredient is practically non-toxic, non-allergenic and non-pathogenic to mammals

* *Figures obtained from Material Safety Data Sheets for each individual product.*

Pesticide Injury to Vegetable Crops

Although greenhouse pesticides have been selected and formulated to avoid plant injury, damage can still occur under some conditions. Consider these general rules before applying pesticides:

- No product is safe on all plants under all conditions, although wettable powders are generally less injurious than liquid formulations.
- Weather conditions at the time of application are important. Pesticides are more likely to harm plants when applied during bright sunny weather than if applied during dull, overcast conditions.
- Well-watered, unstressed plants are less likely to be damaged by pesticides.
- Low-volume applications are generally less likely to cause plant injury than high-volume applications.
- Excessive spray pressure may damage leaf tissue.

Chapter 4. Tomatoes

Products registered for tomato insect and mite pests are listed in Table 4–1, *Products Registered for Tomato Insect and Mite Pests.* Products registered for tomato diseases are listed in Table 4–2, *Products Registered for Tomato Diseases.*

Table 4–1. Products Registered for Tomato Insect and Mite Pests

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Aphids	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months or at 35°C for no more than 1 month.
	DDVP 20% EC	dichlorvos	6 mL/L	24	7	Crop damage can occur particularly under hot, humid conditions. Thoroughly ventilate greenhouse before re-entering on the day following treatment.
	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.
	Endeavor 50WG	pymetrozine	100–200 g/ha in a minimum of 1,000 L/ha	12	3	Do not exceed two applications per crop cycle. Do not apply more than three applications per greenhouse per year in greenhouses with multiple crop cycles. Do not re-apply for at least 7 days. On hard-to-wet plants add a nonionic or organosilicone-based surfactant to improve coverage.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.

Table 4–1. Products Registered for Tomato Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Aphids *Continued*	Intercept 60 WP	imidacloprid	16 g/60 L/1,000 mature plants	–	1	Do not apply more than once per season. Repellency of bumblebee pollinators and negative effects on some beneficials (*Orius* sp.) can occur.
	Thionex 50 W	endosulfan	1.1 kg/ha	48	2	Spray when insects are first observed.
	Thionex EC	endosulfan	1.25 L/ha	48	2	Spray when insects are first observed.
Banana moth *(Opogona sacchari)*	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.8 kg/1,000 L	–	0	Foliar application. Make application just prior to egg hatch. Apply the product such that it flows along the stem, coating it well. Thorough coverage of foliage and stems is necessary (minimum of 300 L of water per hectare). Re-apply at 7-day intervals, as required by monitoring.
Cabbage loopers	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.92 kg/1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
	Bioprotec CAF Aqueous Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	1.8 L/1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
	Confirm 240F	tebufenozide	0.6 L/ha	12	2	Use application interval of at least 10 days. Do not exceed four applications/year.
	DiPel 2X DF	*Bacillus thuringiensis* subsp. *kurstaki*	75–150 g/ 250 L/4,000 m^2	–	0	Apply to upper and lower portions of the leaves to run-off. Repeat applications will be necessary if a new hatch occurs.
	DiPel WP	*Bacillus thuringiensis* subsp. *kurstaki*	150–300 g/ 250 L/4,000 m^2	–	0	Apply at first sign of infestation and repeat at 7- to 10-day intervals when needed to maintain control. Good coverage of all leaves is essential since the insect must ingest the DiPel for insecticidal action.

Cabbage loopers *Continued*	Foray 48BA Aqueous Concentrate	*Bacillus thuringiensis* subsp. *kurstaki*	0.6–1.8 L in 500–1,000 L/ha	–	0	Apply at the first signs of larval infestations. Repeat applications as necessary to maintain control of young larvae. The exact timing and number of applications will depend on foliage development and larval activity, including extent of egg hatch, stage of larval development and population pressure.
Duponchelia fovealis	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.8 kg/1,000 L	–	0	Foliar and drench application. Make application when egg hatch is essentially complete but before crop damage occurs. Apply the product such that it flows along the stem, coating it well, and into the top layer of the soil around the base of the plant. Thorough coverage of foliage and stems is necessary. Re-apply at 7-day intervals, as required by monitoring.
	DiPel 2X DF	*Bacillus thuringiensis* subsp. *kurstaki*	625 g/1,000 L	0	0	Make applications when egg hatch is essentially complete but before crop damage occurs. Apply the product such that it flows along the stem, coating it well, and into the top layer of the soil around the base of the plant. Thorough coverage of foliage and stem is necessary. Apply every 7 days, as required by monitoring.
Earwigs	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
Fungus gnats	VectoBac 600L	*Bacillus thuringiensis* subsp. *israelensis*	2–8 L/1,000 L	–	0	Do not mix and apply with fertilizers or fungicides containing copper or chlorine as this may neutralize the active ingredients.
Leafminer (*Liriomyza* sp.)	Avid 1.9 % EC	abamectin	30 mL/100 L	Do not re-enter treated areas until residues have dried.	3	Application should be made preferably in 2,000–4,000 L of water/ha. If volumes of water below 2,000 L must be used, apply a minimum of 600 mL/ha. If volumes of water greater than 4,000 L of water/ha are required for good plant coverage, apply a maximum rate of 1,200 mL/ha.
Psyllids	Avid 1.9 % EC	abamectin	30 mL/100 L	Do not re-enter treated areas until residues have dried.	3	Application should be made preferably in 2,000–4,000 L of water/ha. If volumes of water below 2,000 L must be used, apply a minimum of 600 mL/ha. If volumes of water greater than 4,000 L of water/ha are required for good plant coverage, apply a maximum rate of 1,200 mL/ha.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.

Table 4–1. Products Registered for Tomato Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[1]	Pre-harvest Interval (days)[2]	Remarks
Slugs & snails	Sluggo	ferric phosphate	25–50 kg/ha (2.5–5 g/m^2)	–	–	Re-apply bait as needed or at least every 2 weeks if slugs and snails continue to be a problem.
Thrips	BotaniGard WP	*Beauveria bassiana*	500–1,000 g/ 400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
Tomato hornworm	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.46–0.92 kg/ 1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
	Bioprotec CAF Aqueous Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.9–1.8 L/ 1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
Tomato pinworm	3M Sprayable Tomato Pinworm Pheromone	pheromone concentrate of tomato pinworm	200 mL/ha	12	–	This product may be applied with high-volume hydraulic sprayers in 300–450 L water per hectare or by low-volume foggers in 10 L water per hectare. Repeat applications are dependent on pest pressure and should, in general, be done 3–4 weeks apart.
Two-spotted spider mites	Avid 1.9% EC	abamectin	30 mL/100 L	Do not re-enter treated areas until residues have dried.	3	Application should be made preferably in 2,000–4,000 L of water/ha. If volumes of water below 2,000 L must be used, apply a minimum of 600 mL/ha. If volumes of water greater than 4,000 L of water/ha are required for good plant coverage, apply a maximum rate of 1,200 mL/ha.

Two-spotted spider mites *Continued*	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.
	DynoMite 75 WP	pyridaben	284 g/1,000 L/ha	12	2	The maximum number of applications per crop cycle is two. Apply at intervals of at least 28 days.
	Floramite SC	bifenazate	133 mL/400 L	12	0	Only two applications per crop cycle are allowed.
	Forbid 240 SC	spiromesifen	30–50 mL/100 L	12	3	The maximum number of applications per crop cycle is two.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
	Vendex 50 WP	fenbutatin oxide	50 g/100 L	12	5	The addition of a suitable spreader-sticker will usually result in superior mite control on these crops. Begin applications when mites appear, and repeat as necessary to maintain control.
Whiteflies	Ambush 50 EC	permethrin	200 mL/1,000 L	–	1	Apply to achieve thorough coverage. Repeat as necessary.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	DDVP 20% EC	dichlorvos	6 mL/L	24	7	Crop damage can occur, particularly under hot, humid conditions. Thoroughly ventilate before re-entering on the day following treatment.
	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.

Table 4–1. Products Registered for Tomato Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Whiteflies *Continued*	Distance	pyriproxyfen	45 mL/100 L	12	3	The maximum number of applications per crop cycle is two. Make the first application when adults begin to appear.
	Forbid 240 SC	spiromesifen	30–50 mL/100 L	12	3	The maximum number of applications per crop cycle is two.
	Insecticidal Soap	potassium salts of fatty acids	1 L/100 L	–	5	Apply when insects occur, and repeat as needed.
	Intercept 60 WP	imidacloprid	16 g/60 L/1,000 mature plants	–	1	Do not apply more than once per season. Repellency of bumblebee pollinators and negative effects on some beneficials (*Orius* sp.) can occur.
	Pounce 384 EC	permethrin	260 mL/1,000 L	–	1	Apply to achieve thorough coverage. Repeat as necessary.
	Thionex 50 W	endosulfan	1.1 kg/ha	48	2	Spray when insects are first observed.
	Tristar 70 WSP	acetamiprid	15 packs/2 ha	12	1	A maximum of two applications per year per greenhouse is allowed. Apply through drip irrigation to the growing media. This is the only approved application method.
	Thionex EC	endosulfan	1.25 litres/ha	48	2	Spray when insects are first observed.

[1] DF = Dry Flowable; EC = Emulsifiable Concentrate; F = Flowable; SC = Sprayable Concentrate; W, WP = Wettable Powder; WG = Wettable Granules; WSP = Water-Soluble Packs

[2] "–" indicates no information was provided on the product label.

Table 4–2. Products Registered for Tomato Diseases

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[1]	Pre-harvest Interval (days)[2]	Remarks
Bacterial blight *(Pseudomonas syringae)*	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
Bacterial canker	Copper Spray Fungicide	copper oxychloride	3 kg/1,000 L/ha	–	1	Apply early in the season and repeat at 7- to 10-day intervals.
Botrytis grey mould	Botran 75W	dicloran	1.75 kg/1,000 L	–	1	Seedlings or newly set transplants may be injured by drenching.
	Decree	fenhexamid	1.5 kg/ha	4	1	Do not make more than three applications per crop cycle.
	Prestop	*Gliocladium catenulatum*	Apply sufficient 0.5% suspension to wet plants, but not to run-off	4	0	Repeat applications every 3 to 4 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Pristine WG	boscalid + pyraclostrobin	1.6 kg/ha in a minimum water volume of 250 L/ha	Do not re-enter until sprays have dried.	0	Do not apply more than once per crop cycle. Do not apply this product using any type of fogger or mister.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	3.75–7.5 g/L	4	–	Apply to foliage every 7–14 days depending upon disease pressure.
	Rovral 50 WP	iprodione	1 kg/1,000 L	12	2	Spray to run-off, ensuring good coverage of the plants, particularly stem nodes, immediately following any pruning.
	Scala SC	pyrimethanil	2 L/ha	–	1	Do not make more than one application per growing season. Apply at first sign of grey mould or in rotation with other registered products. Thorough ventilation after spraying is essential to avoid brown or necrotic spots that can be caused by vapour activity of Scala SC.

Table 4–2. Products Registered for Tomato Diseases *continued*

Disease	Trade Name[1]	Common Name	Rate	Re-entry interval (hr)[2]	Pre-harvest interval (days)[2]	Remarks
Damping-off in seedlings	Maestro 80 DF	captan	1.25 kg/1,000 L; apply 50–85 L/ 100 m^2	48	–	Work into the upper 7.5–10 cm of soil before planting.
Early blight	Manzate Pro-Stick	mancozeb	2.4 kg/ha	–	7	Apply every 7 to 12 days to keep new growth covered.
Fungus root rot diseases	Supra Captan 80 WDG	captan	Use 1.25 kg/ 1,000 L and apply at rates of 50–85 L/100 m^2	48	–	Work into the upper 7.5–10 cm of soil before planting.
***Fusarium* spp.**	Mycostop	*Streptomyces griseoviridis*	Immediately after transplanting: 10–50 mg/plant or 20–100 mL/ plant of 0.05% suspension	4	0	Repeat treatments at intervals of 3–6 weeks depending on disease pressure.
	RootShield Granules	*Trichoderma harzianum*	600–750 g/m^3 of planting mix or soil	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
Late blight	Manzate Pro-Stick	mancozeb	2.4 kg/ha	–	7	Apply every 7 to 12 days to keep new growth covered.
	Revus	mandipropamid	400–600 mL/ha	12	1	Do not apply more than four applications per season. Applications should begin prior to disease development and continue throughout the season on a 7–10-day schedule of fungicides, following the resistance management guidelines. Use of a nonionic adjuvant (0.125% v/v) is recommended. Refer to label for recommended water volume.

***Phytophthora* spp.**	Mycostop	*Streptomyces griseoviridis*	Immediately after transplanting: 10–50 mg/plant or 20–100 mL/plant of 0.05% suspension	4	0	Repeat treatments at intervals of 3–6 weeks depending on disease pressure.
Powdery mildew	MilStop	potassium bicarbonate	5.6 kg/ha	4	0	Do not mix with with other soluble fertilizers or pesticides. This product is not compatible with mild alkaline solutions. Addition of surfactant or wetting agent is not required.
	Nova 40W (WSP)	myclobutanil	340 g/ha (1,000 L/ha)	Do not re-enter treated areas until sprays have dried.	3	Apply no more than two applications/year.
	Pristine WG	boscalid + pyraclostrobin	1.6 kg/ha in a minimum water volume of 250 L/ha	Do not re-enter treated areas until sprays have dried.	0	Do not apply more than once per crop cycle. Do not apply this product using any type of fogger or mister.
	Sulphur (Bartlett's Microscopic Sulphur 92%)	sulphur	750 g/1,000 L/ha	24	1	A maximum of 10 applications per crop cycle is allowed. This product may cause slight foliage damage.
Pythium root rot	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Previcur N	propamocarb hydrochloride	Use 10 mL/10 L of water and apply this solution at a rate of 100–200 mL/plant. Use higher rate for 2nd and 3rd applications.	12	5	A maximum of four applications per crop cycle is allowed — no more than two applications on seedlings and no more than two applications after transplanting. Occasional slight damage may occur following overhead drenching of recently planted seedlings.

Table 4–2. Products Registered for Tomato Diseases *continued*

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Pythium root rot *Continued*	RootShield Granules	*Trichoderma harzianum*	600–750 g/m³ of planting mix or soil	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m³ of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
***Rhizoctonia* sp.**	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/ 2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	RootShield Granules	*Trichoderma harzianum*	600–750 g/m³ planting mix or soil	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m³ of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
Septoria leaf spot	Manzate Pro-Stick	mancozeb	2.4 kg/ha	–	7	Apply every 7 to 12 days to keep new growth covered.

[1] DF = Dry Flowable; SC = Sprayable Concentrate; W, WP = Wettable Powder; WDG = Water-Dispersible Granules; WG = Wettable Granules; WSP = Water-Soluble Packs

[2] "–" indicates no information was provided on the product label.

5. Cucumbers

Products registered for cucumber insect and mite pests are listed in Table 5–1, *Products Registered for Cucumber Insect and Mite Pests.* Products registered for cucumber diseases are listed in Table 5–2, *Products Registered for Cucumber Diseases.*

Table 5–1. Products Registered for Cucumber Insect and Mite Pests

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Aphids	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	DDVP 20% EC	dichlorvos	6 mL/L	24	7	Crop damage can occur, particularly under hot, humid conditions. Thoroughly ventilate before re-entering on the day following treatment.
	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.
	Endeavor 50WG	pymetrozine	100–200 g/ha in a minimum of 1,000 L/ha	12	3	Do not exceed two applications per crop cycle. Do not apply more than three applications per greenhouse per year in greenhouses with multiple crop cycles. Do not reapply for at least 7 days. On hard-to-wet plants add a nonionic or organosilicone-based surfactant to improve coverage.

Table 5–1. Products Registered for Cucumber Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[3]	Remarks
Aphids *Continued*	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
	Intercept 60 WP	imidacloprid	16 g/80 L/1,000 mature plants	–	1	Do not apply more than once per season. Negative effects on some beneficials (*Orius* sp.) can occur.
	Thionex 50 W	endosulfan	1.1 kg/ha	48	2	Spray when insects are first observed.
	Thionex EC	endosulfan	1.25 L/ha	48	2	Spray when insects are first observed.
Banana moth *(Opogona sacchari)*	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.8 kg/1,000 L	–	0	Foliar application. Make application just prior to egg hatch. Apply the product such that it flows along the stem, coating it well. Thorough coverage of foliage and stems is necessary (minimum of 300 L of water per hectare). Reapply at 7-day intervals, as required by monitoring.
Cabbage loopers	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.92 kg/1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
	Bioprotec CAF Aqueous Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	1.8 L/1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
	Foray 48BA Aqueous Concentrate	*Bacillus thuringiensis* subsp. *kurstaki*	0.6–1.8 L in 500–1,000 L/ha	–	0	Apply at the first signs of larval infestations. Repeat applications as necessary to maintain control of young larvae. The exact timing and number of applications will depend on foliage development and larval activity, including extent of egg hatch, stage of larval development and population pressure.

Duponchelia fovealis	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.8 kg/1,000 L	–	0	Foliar and drench application. Make application when egg hatch is essentially complete but before crop damage occurs. Apply the product such that it flows along the stem, coating it well, and into the top layer of the soil around the base of the plant. Thorough coverage of foliage and stems is necessary. Reapply at 7-day intervals, as required by monitoring.
	DiPel 2X DF	*Bacillus thuringiensis* subsp. *kurstaki*	625 g/1,000 L	–	0	Make applications when egg hatch is essentially complete but before crop damage occurs. Apply the product such that it flows along the stem, coating it well, and into the top layer of the soil around the base of the plant. Thorough coverage of foliage and stem is necessary. Apply every 7 days as required by monitoring.
Earwigs	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
Fungus gnats	VectoBac 600L	*Bacillus thuringiensis* subsp. *israelensis*	2–8 L/1,000 L	–	0	Do not mix and apply with fertilizers or fungicides containing copper or chlorine as this may neutralize the active ingredients.
Leafminer (*Liriomyza* spp.)	Avid 1.9 % EC	abamectin	30 mL/100 L	Do not re-enter treated areas until residues have dried.	3	Application should be made preferably in 2,000–4,000 L of water/ha. If volumes of water below 2,000 L must be used, apply a minimum of 600 mL/ha. If volumes of water greater than 4,000 L of water/ha are required for good plant coverage, apply a maximum rate of 1,200 mL/ha.
Leafrollers	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.
Mealy bugs	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.
Psyllids	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.

Table 5–1. Products Registered for Cucumber Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Slugs & snails	Sluggo	ferric phosphate	25–50 kg/ha (2.5–5 g/m^2)	–	–	Re-apply bait as needed or at least every 2 weeks if slugs and snails continue to be a problem.
Thrips	BotaniGard ES	*Beauveria bassiana*	2 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	500–1,000 g/ 400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
Two-spotted spider mite	Avid 1.9 % EC	abamectin	30 mL/100 L	Do not re-enter treated areas until residues have dried.	3	Application should be made preferably in 2,000–4,000 L of water/ha. If volumes of water below 2,000 L must be used, apply a minimum of 600 mL/ha. If volumes of water greater than 4,000 L of water/ha are required for good plant coverage, apply a maximum rate of 1,200 mL/ha.
	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.
	DynoMite 75 WP	pyridaben	284 g/ha using 1,000 L/ha	12	2	The maximum number of applications per crop cycle is two. Apply at intervals of at least 28 days.
	Floramite	bifenazate	133 mL/400 L	12	1	Only two applications per crop cycle are allowed.
	Forbid 240 SC	spiromesifen	30–50 mL/100 L	12	3	The maximum number of applications per crop cycle is two.

Two-spotted spider mite *Continued*	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
	Vendex 50 WP	fenbutatin oxide	50 g/100 L	12	3	The addition of a suitable spreader-sticker will usually result in superior mite control on these crops. Begin applications when mites appear, and repeat as necessary to maintain control.
Whiteflies	Ambush 50 EC	permethrin	200 mL/1,000 L	–	1	Apply to achieve thorough coverage. Repeat as necessary.
	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	DDVP 20% EC	dichlorvos	6 mL/L	24	7	Crop damage can occur, particularly under hot, humid conditions. Thoroughly ventilate before re-entering on the day following treatment.
	Dibrom	naled	10 mL/100 m^3	24	1	Apply undiluted to cold pipes, then heat to 41°C and close greenhouse for at least 4 hours. Avoid overtreatment and direct application to plants as plant injury may result. Greenhouses must be fully ventilated before re-entry.
	Distance	pyriproxyfen	45 mL/100 L	12	3	The maximum number of applications per crop cycle is two. Make the 1st application when adults begin to appear.
	Forbid 240 SC	spiromesifen	30–50 mL/100 L	12	3	The maximum number of applications per crop cycle is two.
	Insecticidal Soap	potassium salts of fatty acids	1 L/100 L	–	5	Apply when insects occur, and repeat as needed.

Table 5–1. Products Registered for Cucumber Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Whiteflies *Continued*	Intercept 60 WP	imidacloprid	16 g/80 L/1,000 mature plants	–	1	Do not apply more than once per season. Negative effects on some beneficials (*Orius* sp.) can occur.
	Pounce 384 EC	permethrin	260 mL/1,000 L	–	1	Apply to achieve thorough coverage. Repeat as necessary.
	Thionex 50 W	endosulfan	1.1 kg/ha	48	2	Spray when insects are first observed.
	Thionex EC	endosulfan	1.25 L/ha	48	2	Spray when insects are first observed.

[1] DF = Dry Flowable; EC = Emulsifiable Concentrate; ES = Emulsifiable Suspension; SC = Sprayable Concentrate; W, WP = Wettable Powder; WG = Wettable Granules

[2] "–" indicates no information was provided on the product label.

Table 5–2. Products Registered for Cucumber Diseases

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Botrytis cinerea	Prestop	*Gliocladium catenulatum*	Apply sufficient 0.5% suspension to wet plants, but not to run-off	4	0	Repeat applications every 3 to 4 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Rovral	iprodione	1 kg/1,000 L	12	2	Spray to run-off ensuring good coverage of the plants, particularly stem nodes immediately following any pruning.
Cercospora leaf spot *(Cercospora citrullina)*	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
Downy mildew *(Pseudo-peronspora cubensis)*	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
***Fusarium* spp.**	Mycostop	*Streptomyces griseoviridis*	Immediately after transplanting: 10–50 mg/plant or 20–100 mL/plant of 0.05% suspension	4	0	Repeat treatments at intervals of 3–6 weeks depending on disease pressure.
	Prestop	*Gliocladium catenulatum*	125–250 mL of 1.0% suspension/10 L of growth media, or 100 L of 1.0% suspension/2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.

Table 5–2. Products Registered for Cucumber Diseases *continued*

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
***Fusarium* spp.** *Continued*	RootShield Granules	*Trichoderma harzianum*	600–750 g/m³ of planting mix or soil	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m³ of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
Gummy stem blight	Nova 40W	myclobutanil	340 g/ha	Do not enter treated areas until sprays have dried.	2	Do not apply more than six times per year.
	Prestop	*Gliocladium catenulatum*	Apply sufficient 1.0% suspension to wet plants, but not to run-off	4	0	Repeat applications every 3 to 4 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Pristine WG	boscalid + pyraclostrobin	1.3 kg/ha in a minimum water volume of 250 L/ha	Do not re-enter treated areas until sprays have dried.	0	Do not apply more than once per crop cycle. Do not apply this product using any type of fogger or mister.
	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
	Rovral	iprodione	1 kg/1,000–2,000 L/ha	12	2	Spray to run-off ensuring good coverage of the plants, particularly stem nodes immediately following any pruning.
Powdery mildew	Kumulus DF	sulphur	120 g/100 L	24	1	Apply once every 5 days as required.

Powdery mildew *Continued*	Microscopic Sulphur WP	sulphur	105 g/100 L	24	1	Do not apply Microscopic Sulphur Fungicide if high temperature (above 25°C) and high humidity prevail or are expected during the three days following application.
	Microthiol Disperss	sulphur	120 g/100 L	24	1	Do not apply more than 0.04 kg/ha/application during periods of high temperatures.
	MilStop	potassium bicarbonate	5.6 kg/ha	4	0	Do not mix with with other soluble fertilizers or pesticides; this product is not compatible with mild alkaline solutions. Addition of surfactant or wetting agent is not required.
	Nova 40W (WSP)	myclobutanil	340 g/ha	Do not re-enter treated areas until sprays have dried.	2	Do not apply more than six times per year.
	Pristine WG	boscalid + pyraclostrobin	1.3 kg/ha in a minimum water volume of 250 L/ha	Do not re-enter treated areas until sprays have dried.	0	Do not apply more than once per crop cycle. Do not apply this product using any type of foggers or misters.
	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
Pythium root rot	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Previcur N	propamocarb hydrochloride	Use 10 mL/10 L and apply this solution at a rate of 100–200 mL/plant. Use higher rate for 2nd and 3rd applications.	12	2	The maximum number of applications per crop cycle is four; no more than two applications on seedlings, and no more than two applications after transplanting. Occasional slight damage may occur following overhead drenching of recently planted seedlings.

Table 5–2. Products Registered for Cucumber Diseases *continued*

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Pythium root rot *Continued*	Ridomil Gold 480 EC or Ridomil Gold 480 SL	metalaxyl-M	Apply 250 mL of solution (0.75–1.25 mL product/10 L water)	12	21	Apply once per crop cycle, immediately after transplanting, as a drench to the growing media at the base of each plant; this product cannot be used for cucumbers grown in soil. Do not use in the propagation house. Do not apply to cucumbers intended for field production.
	RootShield Granules	*Trichoderma harzianum*	600–750 g/m^3 of planting mix or soil	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
Rhizoctonia solani	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/ 2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	RootShield Granules	*Trichoderma harzianum*	600–750 g/m^3 of planting mix or soil	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.

[1] DF = Dry Flowable; EC = Emulsifiable Concentrate; SL = Solution; W, WP = Wettable Powder; WG = Wettable Granules; WSP = Water-Soluble Packs

[2] "–" indicates no information was provided on the product label.

Chapter 6. Peppers

Products registered for pepper insect and mite pests are listed in Table 6–1, *Products Registered for Pepper Insect and Mite Pests.* Products registered for pepper diseases are listed in Table 6–2, *Products Registered for Pepper Diseases.*

Table 6–1. Products Registered for Pepper Insect and Mite Pests

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Aphids	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	Diazinon 500 EC	diazinon	575 mL/625 L (this is equivalent to 230 mL/250 L over 4,000 m²)	–	5	Use conventional high-volume power sprayers.
	Endeavor 50WG	pymetrozine	100–200 g/ha in a minimum of 1,000 L/ha	12	3	Do not exceed two applications per crop cycle. Do not apply more than three applications per greenhouse per year in greenhouses with multiple crop cycles. Do not reapply for at least 7 days. On hard-to-wet plants add a nonionic or organosilicone-based surfactant to improve coverage.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	This product may cause damage to flowers under high-temperature conditions.

Table 6–1. Products Registered for Pepper Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Aphids *Continued*	Intercept 60 WP	imidacloprid	**Transplant tray plug drench:** 4.1 g/1,000 seedlings in a solution application rate of 8 L/100 m^2 of seedling trays **Mature plants:** 16 g in 70 L/ 1,000 plants	–	3	**Transplants:** Apply to 2–3-week-old seedlings in flats. Make one application per growing season. **Mature plants:** Applications should be made when infestation pressure surpasses threshold and beneficials are not able to maintain pest populations below damage thresholds. Do not apply more than once per season. Repellency of bumblebee pollinators and negative effects on some beneficials (*Orius* sp.) can occur.
	Thiodan 4 EC	endosulfan	1.25–1.5 L/ 1,000 L	48	2	Do not apply more than twice per season.
	Tristar 70 WSP	acetamiprid	3 water-soluble packs/1,000 L	12	3	Do not exceed five packs/ha. Do not make more than two applications per year. Do not apply when bees are present in the area to be treated.
Banana moth *(Opogona sacchari)*	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.8 kg/1,000 L	–	0	Foliar application. Make application just prior to egg hatch. Apply the product such that it flows along the stem, coating it well. Thorough coverage of foliage and stems is necessary. Reapply at 7-day intervals, as required by monitoring.
Cabbage loopers	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.92 kg/1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, inciuding egg hatch, stage of larval development and population pressure.
	Bioprotec CAF Aqueous Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	1.8 L/1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.

Cabbage loopers *Continued*	Confirm 240F	tebufenozide	0.6 L/ha	12	3	Do not exceed four applications/year. Foliar application only. Applications should be made a minimum of 7 days apart.
	DiPel 2X DF	*Bacillus thuringiensis* subsp. *kurstaki*	75–150 g/250 L /4,000 m^2	–	0	Apply to upper and lower portions of the leaves to run-off. Repeat applications will be necessary if a new hatch occurs.
	DiPel WP	*Bacillus thuringiensis* subsp. *kurstaki*	150–300 g/ 250 L/4,000 m^2	–	0	Apply at first sign of infestation and repeat at 7- to 10-day intervals when needed to maintain control. Good coverage of all leaves is essential since the insect must ingest the DiPel for insecticidal action.
	Foray 48BA Aqueous Concentrate	*Bacillus thuringiensis* subsp. *kurstaki*	0.6–1.8 L in 500–1,000 L/ha	–	0	Apply at the first signs of larval infestations. Repeat applications as necessary to maintain control of young larvae. The exact timing and number of applications will depend on foliage development and larval activity, including extent of egg hatch, stage of larval development and population pressure.
Duponchelia fovealis	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.8 kg/1,000 L	–	0	Foliar and drench application. Make application when egg hatch is essentially complete but before crop damage occurs. Apply the product such that it flows along the stem, coating it well, and into the top layer of the soil around the base of the plant. Thorough coverage of foliage and stems is necessary. Reapply at 7-day intervals, as required by monitoring.
	DiPel 2X DF	*Bacillus thuringiensis* subsp. *kurstaki*	625 g/1,000 L	–	0	Make applications when egg hatch is essentially complete but before crop damage occurs. Apply the product such that it flows along the stem, coating it well, and into the top layer of the soil around the base of the plant. Thorough coverage of foliage and stem is necessary. Apply every 7 days as required by monitoring.
Earwigs	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	This product may cause damage to flowers under high-temperature conditions.
European corn borer	Confirm 240F	tebufenozide	0.5 L/4,000 L/ha	12	3	Ensure good coverage is achieved and apply at intervals of approximately 7 days. Do not exceed four applications per year.
Fungus gnats	VectoBac 600L	*Bacillus thuringiensis* subsp. *israelensis*	2–8 L/1,000 L	–	0	Do not mix or apply with fertilizers or fungicides containing copper or chlorine as this may neutralize the active ingredients.

Table 6–1. Products Registered for Pepper Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Lygus bug or tarnished plant bug	Thiodan 4 EC	endosulfan	1.25–1.5 L/ 1,000 L	48	2	Do not apply more than twice per season.
Psyllids	Avid 1.9 % EC	abamectin	30 mL/100 L	Do not re-enter treated areas until residues have dried.	3	Application should be made preferably in 2,000–4,000 L of water/ha. If volumes of water below 2,000 L must be used, apply a minimum of 600 mL/ha. If volumes of water greater than 4,000 L of water/ha are required for good plant coverage, apply a maximum rate of 1,200 mL/ha.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	This product may cause damage to flowers under high-temperature conditions.
Slugs & snails	Sluggo	ferric phosphate	25–50 kg/ha (2.5–5 g/m^2)	–	–	Re-apply bait as needed or at least every 2 weeks if slugs and snails continue to be a problem.
Thrips	BotaniGard ES	*Beauveria bassiana*	2 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	500–1,000 g/ 400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
Two-spotted spider mite	Avid 1.9 % EC	abamectin	30 mL/100 L	Do not re-enter treated areas until residues have dried.	3	Application should be made preferably in 2,000–4,000 L of water/ha. If volumes of water below 2,000 L must be used, apply a minimum of 600 mL/ha. If volumes of water greater than 4,000 L of water/ha are required for good plant coverage, apply a maximum rate of 1,200 mL/ha.
	DynoMite 75 WP	pyridaben	284 g/ha using 1,000 L/ha	12	3	The maximum number of applications per crop cycle is two. Apply at intervals of at least 28 days.

Two-spotted spider mite *Continued*	Floramite SC	bifenazate	133 mL/400 L	12	1	Only two applications per crop cycle are allowed.
	Forbid 240 SC	spiromesifen	30–50 mL/100 L	12	3	The maximum number of applications per crop cycle is two.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	This product may cause damage to flowers under high-temperature conditions.
Whiteflies	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	Distance	pyriproxyfen	45 mL/100 L	12	3	The maximum number of applications per crop cycle is two. Make the 1st application when adults begin to appear.
	Forbid 240 SC	spiromesifen	30–50 mL/100 L	12	3	The maximum number of applications per crop cycle is two.
	Insecticidal Soap	potassium salts of fatty acids	1 L/100 L	–	5	This product may cause damage to flowers under high-temperature conditions.
	Intercept 60 WP	imidacloprid	**Transplant tray plug drench:** 4.1 g/1,000 seedlings in a solution application rate of 8 L/100 m^2 of seedling trays **Mature plants:** 16 g in 70 L/ 1,000 plants	–	3	**Transplants:** Apply to 2–3-week-old seedlings in flats. Make one application per growing season. **Mature plants:** Applications should be made when infestation pressure surpasses threshold and beneficials are not able to maintain pest populations below damage thresholds. Do not apply more than once per season. Repellency of bumblebee pollinators and negative effects on some beneficials (*Orius* sp.) can occur.

[1] DF = Dry Flowable; EC = Emulsifiable Concentrate; ES = Emulsifiable Suspension; F = Flowable; SC = Sprayable Concentrate; WG = Wettable Granules; WP = Wettable Powder; WSP = Water-Soluble Packs

[2] "–" indicates no information was provided on the product label.

Table 6–2. Products Registered for Pepper Diseases

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Bacterial speck *(Pseudomonas syringae)*	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
Bacterial spot *(Xanthomonas campestris)*	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
Botrytis grey mould	Prestop	*Gliocladium catenulatum*	Apply sufficient 0.5% suspension to wet plants, but not to run-off	4	0	Repeat applications every 3 to 4 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
Damping-off in seedlings	Maestro 80 DF	captan	1.25 kg/1,000 L, apply 50–85 L/ 100 m^2	48	–	Work into the upper 7.5–10 cm of soil before planting.
	Supra Captan 80 WDG	captan	Use 1.25 kg/ 1,000 L and apply at rates of 50–85 L/100 m^2	48	–	Work into the upper 7.5–10 cm of soil before planting.

***Fusarium* spp.**	Mycostop	*Streptomyces griseoviridis*	Immediately after transplanting: 10–50 mg/plant or 20–100 mL/plant of 0.05% suspension	4	0	Repeat treatments at intervals of 3–6 weeks depending on disease pressure.
	RootShield Granules	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
***Phytophthora* sp.**	Mycostop	*Streptomyces griseoviridis*	Immediately after transplanting: 10–50 mg/plant or 20–100 mL/plant of 0.05% suspension	4	0	Repeat treatments at intervals of 3–6 weeks depending on disease pressure.
Powdery mildew	Actinovate	*Streptomyces lydicus*	425 g/1,100 L	1	–	Begin applications at transplant, and make subsequent applications at 7–14-day intervals. Store at 21–26°C for no more than 12 months, away from direct sunlight and heat sources.
	MilStop	potassium bicarbonate	5.6 kg/ha	4	0	Do not mix with with other soluble fertilizers or pesticides; this product is not compatible with mild alkaline solutions. Addition of surfactant or wetting agent is not required.
	Nova 40W (WSP)	myclobutanil	340 g/ha using 1,500–3,000 L water/ha	12	3	Apply as soon as possible after initial infection and again 12 days later when disease pressure warrants control. The maximum number of applications per crop cycle is three.
	Sulphur (Bartletts's Microscopic Sulphur 92%)	sulphur	543–760 g/1,000 L/ha	24	1	A maximum of 10 applications per crop cycle is allowed. Apply on a minimum of 14-day interval.

Table 6–2. Products Registered for Pepper Diseases *continued*

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[3]	Remarks
Pythium root rot	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/ 2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Previcur N	propamocarb hydrochloride	Use 10 mL/10 L applied at a rate of 100–200 mL/ plant. Use higher rate for 2nd and 3rd applications.	12	5	The maximum number of applications per crop cycle is four; no more than two applications on seedlings, and no more than two applications after transplanting. Occasional slight damage may occur following overhead drenching of recently planted seedlings.
	RootShield Granules	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
Rhizoctonia solani	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/ 2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	RootShield Granules	*Trichoderma harzianum*	600–750 g/m^3 of planting mix or soil	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.

Root rot diseases	RootShield Granules	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	RootShield HC Wettable Powder	*Trichoderma harzianum*	55–110 g/m^3 of media using a suspension of 30–45 g/100 L	4	–	This product is effective when the root zone temperature exceeds 10°C and the media pH is neutral or acidic.
	Supra Captan 80 WDG	captan	Use 1.25 kg/ 1,000 L and apply at rates of 50–85 L/100 m^2	48	–	Work into the upper 7.5–10 cm of soil before planting.

[1] DF = Dry Flowable; WDG = Water-Dispersible Granules; WSP = Water-Soluble Packs

[2] "–" indicates no information was provided on the product label.

Chapter 7. Lettuce

Products registered for lettuce insect and mite pests are listed in Table 7–1, *Products Registered for Lettuce Insect and Mite Pests.* Products registered for lettuce diseases are listed in Table 7–2, *Products Registered for Lettuce Diseases.*

Table 7–1. Products Registered for Lettuce Insect and Mite Pests

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[3]	Remarks
Aphids	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
	Malathion 25W	malathion	2.75–5.5 kg/ha	–	Leaf lettuce = 21 Head lettuce = 7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
	Malathion 85E	malathion	735–1,345 mL/ha	–	7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
	Thiodan 4 EC	endosulfan	1.25–1.5 L/ 1,000 L	48	14	Do not apply more than once per season.

Table 7–1. Products Registered for Lettuce Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[3]	Remarks
Armyworms	Malathion 85E	malathion	735–1,345 mL/ha	–	7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
Cabbage loopers	Bioprotec 3P Dry Flowable Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	0.92 kg/1,000L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
	Bioprotec CAF Aqueous Biological Insecticide	*Bacillus thuringiensis* subsp. *kurstaki*	1.8 L/1,000 L	–	0	Apply to young larvae at first signs of infestation. Repeat applications as necessary to maintain control of young larvae. The timing and number of applications will depend on foliage development and larval activity, including egg hatch, stage of larval development and population pressure.
	Confirm 240F	tebufenozide	0.6 L/ha	12	14	Application interval is 10–14 days. Do not exceed two applications/year.
	Foray 48BA Aqueous Concentrate	*Bacillus thuringiensis* subsp. *kurstaki*	0.6–1.8 L in 500 –1,000 L/ha	–	0	Apply at the first signs of larval infestations. Repeat applications as necessary to maintain control of young larvae. The exact timing and number of applications will depend on foliage development and larval activity, including extent of egg hatch, stage of larval development and population pressure.
	Matador 120 EC	lambda-cyhalothrin	83 mL/ha	24	3	Do not apply more than two applications per year. Best used against early stages of loopers.
Caterpillars	Malathion 25W	malathion	2.75–5.5 kg/ha	–	Leaf lettuce = 21 Head lettuce = 7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
Earwigs	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.

Fungus gnats	Citation 75 WP	cyromazine	75 g/570 L (do not exceed 1,010 L of spray solution per ha)	12	14	No more than four applications per growing season. Allow 7 days between applications. Do not apply this product through any type of irrigation equipment. Do not allow effluent or run-off from greenhouses containing this product to enter lakes, streams, ponds or other waters.
	VectoBac 600L	*Bacillus thuringiensis* subsp. *israelensis*	2–8 L/1,000 L	–	0	Do not mix or apply with fertilizers or fungicides containing copper or chlorine as this may neutralize the active ingredients.
Psyllids	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
Slugs & snails	Ferric Phosphate	ferric phosphate	25–50 kg/ha (2.5–5 g/m^2)	–	–	Re-apply bait as needed or at least every 2 weeks if slugs and snails continue to be a problem.
Thrips	BotaniGard ES	*Beauveria bassiana*	2 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	500–1,000 g /400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	Malathion 25W	malathion	2.75–5.5 kg/ha	–	Leaf lettuce = 21 Head lettuce = 7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
	Malathion 85E	malathion	735–1,345 mL/ ha	–	7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
Two-spotted spider mites	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
	Malathion 25W	malathion	2.75–5.5 kg/ha	–	Leaf lettuce = 21 Head lettuce = 7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.

Table 7–1. Products Registered for Lettuce Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Two-spotted spider mites *Continued*	Malathion 85E	malathion	735–1,345 mL/ha	–	7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
Whiteflies	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	Insecticidal Soap	potassium salts of fatty acids	1 L/100 L	–	5	Apply when insects occur, and repeat as needed.
	Malathion 25W	malathion	2.75–5.5 kg/ha	–	Leaf lettuce = 21 Head lettuce = 7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.
	Malathion 85E	malathion	735–1,345 mL/ha	–	7	Do not apply more than twice per season. This product works more effectively if the temperature is 20°C or more.

[1] E, EC = Emulsifiable Concentrate; ES = Emulsifiable Suspension; F = Flowable; W, WP = Wettable Powder

[2] "–" indicates no information was provided on the product label.

Table 7–2. Products Registered for Lettuce Diseases

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Blue mold	Revus	mandipropamid	400–600 mL/ha	12	7	Do not make more than four applications per season. Applications should begin prior to disease development and continue throughout the season on a 7–10-day schedule of fungicides, following the resistance management guidelines. Use of a nonionic adjuvant (0.125% v/v) is recommended.
Botrytis grey mould	Decree 50 WDG	fenhexamid	1.5 kg/ha	4	3	Do not make more than two applications per crop cycle.
	Prestop	*Gliocladium catenulatum*	Apply sufficient 0.5% suspension to wet plants, but not to run-off	4	0	Repeat applications every 3 to 4 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
	Rovral	iprodione	2 kg/ha in 2,000 L/ha	12	14	Use a high-volume sprayer. Apply a maximum of four applications per year.
Downy mildew	Revus	mandipropamid	400–600 mL/ha	12	7	Do not make more than four applications per season. Use of a nonionic adjuvant (0.125% v/v) is recommended.
	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.

Table 7–2. Products Registered for Lettuce Diseases *continued*

Disease	Trade Name[1]	Common Name	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Powdery mildew	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.
Pythium root rot	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/ 2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
Rhizoctonia solani	Prestop	*Gliocladium catenulatum*	125–250 mL of 0.5% suspension/10 L of growth media, or 100 L of 0.5% suspension/ 2,000 plants	4	0	Repeat applications every 3 to 6 weeks. Viability of contents in unopened packets, stored under cool (approx. 4°C), dry conditions, is 12 months. Use entire contents of opened packets on the same day they are opened.
Sclerotinia rot	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.

[1] WDG = Water-Dispersible Granules

[2] "–" indicates no information was provided on the product label.

Chapter 8. Eggplants

Products registered for eggplant insect and mite pests are listed in Table 8–1, *Products Registered for Eggplant Insect and Mite Pests.* Products registered for eggplant diseases are listed in Table 8–2, *Products Registered for Eggplant Diseases.*

Table 8–1. Products Registered for Eggplant Insect and Mite Pests

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Aphids	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
Earwigs	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
Fungus gnats	VectoBac 600L	*Bacillus thuringiensis* subsp. *israelensis*	2–8 L/1,000 L	–	0	Do not mix and apply with fertilizers or fungicides containing copper or chlorine as this may neutralize the active ingredients.
Psyllids	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.

Table 8–1. Products Registered for Eggplant Insect and Mite Pests *continued*

Pest	Trade Name[1]	Common Name or Active Ingredient	Rate	Re-entry Interval (hr)[2]	Pre-harvest Interval (days)[2]	Remarks
Slugs & snails	Ferric phosphate	ferric phosphate	25–50 kg/ha (2.5–5 g/m^2)	–	–	Re-apply bait as needed or at least every 2 weeks if slugs and snails continue to be a problem.
Thrips	BotaniGard ES	*Beauveria bassiana*	2 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	500–1,000 g/ 400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
Two-spotted spider mites	Insecticidal Soap	potassium salts of fatty acids	2 L/100 L	–	5	Apply when insects occur, and repeat as needed.
Whiteflies	BotaniGard ES	*Beauveria bassiana*	0.5–1 L/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	BotaniGard WP	*Beauveria bassiana*	250–500 g/400 L	4	0	High pest populations may require application at 2–5-day intervals. Do not mix more BotaniGard than can be sprayed in 1 day. Spray to wet, but avoid run-off. Do not mix with any fungicide, insecticide or adjuvant. Store at 25°C for no more than 9 months, or at 35°C for no more than 1 month.
	Insecticidal Soap	Potassium salts of fatty acids	1 L/100 L	–	5	Apply when insects occur, and repeat as needed.

[1] ES = Emulsifiable Suspension; WP = Wettable Powder

[2] "–" indicates no information was provided on the product label.

Table 8–2. Products Registered for Eggplant Diseases

Disease	Trade Name	Common Name	Rate	Re-entry Interval (hr)[1]	Pre-harvest Interval (days)[1]	Remarks
Bacterial blight *(Pseudomonas syringae)*	Rhapsody ASO (aqueous suspension)	*Bacillus subtilis*	1.0–2.0 L/100 L	–	0	Apply preventively or in early stages of disease development. Repeat as necessary every 7–10 days. Maintain agitation during mixing and application to ensure uniform coverage. Do not mix in spray tank with pesticides, surfactants or fertilizers.

[1] "–" indicates no information was provided on the product label.

9. Biological Control Agents and Pesticide Compatibility

For greenhouse vegetable growers, using biological control agents (Table 9–1) to manage insect and mite pests is the cornerstone of an integrated pest management program. To optimize use of these agents, growers must be aware of the impact of any pesticides used to reduce insect or mite populations or to suppress disease incidence. Products with the least negative effects will be most compatible with the use of biological control agents. Tables 9–2 and 9–3 list the potential residual effects of several products on biological control agents commonly used in greenhouse vegetable crops.

Table 9–1. Biocontrol Agents for Major Greenhouse Pests

Pests	Biocontrol Agent
Aphids: various species Green peach aphid *(Myzus persicae)* Melon aphid *(Aphis gossypii)*	*Aphidius* spp. (parasitic wasps)* *Aphidoletes aphidimyza* (predatory midge)** Lacewings Ladybeetles (*Hippodamia* sp.)
Caterpillars (cabbage loopers, European corn borers)	*Bacillus thuringiensis* (bacterium sold as DiPel, Foray etc.) *Cotesia marginiventris* (parasitic wasp) *Trichogramma* spp. (parasitic wasps)*
Fungus gnat (*Bradysia* and *Corynoptera* spp.)	*Atheta coriaria* (predatory beetle)** *Bacillus thuringiensis* (bacterium sold as Vectobac) *Hypoaspis* spp. (predatory mites)** *Steinernema* sp. (nematode)**
Leafminer *(Liriomyza* spp.)	*Dacnusa* sp. (parasitic wasp) * *Diglyphus* sp. (parasitic wasp)*
Spider mite *(Tetranychus urticae)*	*Amblyseius californicus* (predatory mite)** *Feltiella acarisuga* (predatory midge)** *Phytoseiulus persimilis* (predatory mite)** *Stethorus punctillum* (predatory beetle)**

Table 9–1. Biocontrol Agents for Major Greenhouse Pests *continued*

Pests	Biocontrol Agent
Whitefly *(Trialeurodes vaporariorum* or *Bemisia argentifolii)*	*Delphastus pusillus* (predatory beetle)** *Dicyphus hesperus* (predatory bug)** *Encarsia formosa* (parasitic wasp)* *Eretmocerus eremicus* (parasitic wasp)*
Western flower thrips *(Frankliniella occidentalis)*	*Amblyseius* spp. (predatory mites)** *Atheta coriaria* (predatory beetle)** *Hypoaspis* sp. (predatory mite)** *Orius* spp. (predatory bug)** *Steinernema feltiae* (nematode)**

* Parasitoids: These usually require only one host for completion of development, often killing it by living on or in its body.

** Predators: These feed on their prey (pest) by catching them but otherwise live independently of them. They must consume more than one individual to reach maturity.

Caution is required when using pesticides along with biocontrols since most pesticides are harmful to beneficial insects. Using even one application of harmful pesticide can prevent any further use of biocontrol agents for an extended period of time. See Table 9–2 and Table 9–3.

Table 9–2. Reported Effects of Registered Insecticides/Miticides on Biological Control Agents[a,b,c]

Insecticides	*Encarsia formosa* + *Aphidius*	*Phytoseiulus persimilis*	*Amblyseius cucumeris* + *Hypoaspis*	*Aphidoletes aphidimyza*	*Orius* spp.
Ambush/Pounce	H (56–84)	H (14–84)	H (56–84)	H (56–84)	H (56–84)
Avid	H (21)	H (14)	H (14)	H (21)	H (21)
Basudin	H (28–42)	H (7)	H (7–21)	H (42–56)	H (30)
Bioprotec	S (0)	S (0)	S (0)	S (0)	S (0)
Citation	S	S	S	H	I (7)
Confirm	S	I	S	–	I
Diazinon	H (28–42)	H (7)	H (7–21)	H (42–56)	H (30)
Dibrom (Fumigant)	H (7)	H (3–7)	H (3)	H (7)	H (3)

DiPel	S (0)	S (0)	S (0)	S (0)	S (0)
Distance	H (35)	S	S	I (0–7)	S
Dyno-Mite	H (>28)	H (7)	H (28–36)	H (>28)	H (28–35)
Endeavor	I (0)	S	S	I	S
Floramite	–	I (7)	–	–	S
Foray	S (0)	S (0)	S (0)	S (0)	S (0)
Insecticidal Soap	H (0)	H (0)	H (0)	H (0)	H (0)
Intercept	S	S (0)	S (0)	S	H (28–42)
Malathion	H (56–84)	H (7–14)	H (56–84)	H (14–70)	H
Nicotine (Fumigant)	I (3)	H	H (1–7)	H (1–7)	I
Thiodan	H (56–84)	H (4–14)	H (42–70)	H (56–84)	H
Vectobac	S	S	S	S	S
Vendex	S	S	S	S	S

[a] S = Safe; H = Harmful; I = Intermediate; numbers in parentheses refer to residual toxicity to biological agent, in days, where reliable data exists. "–" indicates no data is available.

[b] This table serves only as a guide to possible effects of pesticides. Variations in toxicity may occur under varying conditions.

[c] This table was compiled from information produced by Applied Bionomics Ltd. (www.appliedbio-nomics.com/technical-manual/180-chemical-effect.pdf), Biobest Biological Systems (www.biobest.be/neveneffecten/3/3/) and Koppert Biological Systems (http://side-effects.koppert.nl). Where differences existed in the available information, it provides either a range of residual toxicities or the more conservative figure. Please refer to these websites for more comprehensive information.

Table 9–3. Reported Effects of Registered Fungicides on Biological Control Agents[a,b,c]

Fungicides	*Encarsia formosa* + *Aphidius*	*Phytoseiulus persimilis*	*Amblyseius cucumeris* + *Hypoaspis*	*Aphidoletes aphidimyza*	*Orius* spp.
Beniate	S (0)	H (14–21)	H (14–21)	S (0)	S (0)
Botran	S	S	S	S	–
Captan	S (0)	S (0)	S (0)	S (0)	S (0)
Decree	–	I	–	–	I
Maestro	S (0)	S (0)	S (0)	S (0)	S (0)
Manzate	S (0)	S (0)	S	H	S (0)
Mycostop	S	S	S	S	S
Nova	S	S (0)	–	–	S (0)
Previcur	S (0)	S (0)	S	–	I
Pristine	S	S	S	S	S
Ridomil Gold	S	H	I	–	–
Rootshield	S	S	S	S	S
Rovral	S (0)	S (0)	S (0)	S (0)	S (0)
Sulphur	H (>28)	S (0)	I	I	S

[a] S = Safe; H = Harmful; I = Intermediate; numbers in parentheses refer to residual toxicity to biological agent, in days, where reliable data exists.
" –" indicates no data is available.

[b] This table serves only as a guide to possible effects of pesticides. Variations in toxicity may occur under different conditions.

[c] This table was compiled from information produced by Applied Bionomics Ltd. (www.appliedbio-nomics.com/technical-manual/180-chemical-effect.pdf), Biobest Biological Systems (www.biobest.be/neveneffecten/3/3/) and Koppert Biological Systems (http://side-effects.koppert.nl). Where differences existed in the available information, it provides either a range of residual toxicities or the more conservative figure. Please refer to these websites for more comprehensive information.

10. Appendices

Appendix A. OMAFRA Greenhouse Vegetable Staff

Gillian Ferguson
Greenhouse Vegetable IPM Specialist
Greenhouse and Processing Crops Research Centre
2585 County Road 20
Harrow, ON N0R 1G0
Tel: 519-738-1258
Fax: 519-738-4564
Email: gillian.ferguson@ontario.ca

Shalin Khosla
Greenhouse Vegetable Specialist
Greenhouse and Processing Crops Research Centre
2585 County Road 20
Harrow, ON N0R 1G0
Tel: 519-738-1257
Fax: 519-738-4564
Email: shalin.khosla@ontario.ca

A complete list of Ontario Ministry of Agriculture, Food and Rural Affairs advisory staff is available on the OMAFRA website at www.ontario.ca/crops.

Agricultural Information Contact Centre
Provides province-wide, toll-free technical and business information to commercial farms, agri-businesses and rural businesses
1 Stone Road West
Guelph, ON N1G 4Y2
Tel: 1-877-424-1300
Fax: 519-826-3442
Email: ag.info.omafra@ontario.ca

Appendix B. Diagnostic Services

Samples for disease diagnosis, insect or weed identification, nematode counts and *Verticillium* testing can be sent to:

Pest Diagnostic Clinic
Laboratory Services Division
University of Guelph
95 Stone Road West
Guelph, ON N1H 8J7
Tel: 519-767-6256
Fax: 519-767-6240
Email: pdc@lsd.uoguelph.ca

Payment must accompany samples at the time of submission. Submission forms are available at www.labservices.uoguelph.ca/units/pdc/.

Fee schedule

To obtain information on the fee schedule, visit www.labservices.uoguelph.ca/units/pdc/ or phone the Pest Diagnostic Clinic at 519-767-6256.

Submitting Plant Samples for Disease Diagnosis or Identification

Sample Submission Forms

Forms can be downloaded from the University of Guelph Laboratory Services' Pest Diagnostic Clinic website at www.labservices.uoguelph.ca/units/pdc/. Carefully fill in all of the categories on the form.

Choose a complete, representative sample showing early symptoms. Submit as much of the plant as is practical, including the root system, or several plants showing a range of symptoms. If symptoms are general, collect the sample from an area where they are of intermediate severity. Completely dead material is usually inadequate for diagnosis.

With plant specimens submitted for identification, include at least a 20–25 cm sample of the top portion of the stem with lateral buds, leaves, flowers or fruits in identifiable condition. Wrap plants in newspaper and put in a plastic bag. Tie the root system off in a separate plastic bag to prevent the roots from drying out and the soil from contaminating the leaves. Do not add moisture, as this encourages decay in transit. Cushion specimens and pack them in a sturdy box to avoid damage during shipping. Avoid leaving specimens to bake or freeze in a vehicle or in a location where they could deteriorate.

Delivery

Deliver to the Pest Diagnostic Clinic as soon as possible by first class mail or by courier at the beginning of the week.

Submitting Insect Specimens for Identification

Collecting Samples

Place dead, hard-bodied insects in vials or boxes and cushion them with tissues or cotton. Place soft-bodied insects and caterpillars in vials containing alcohol. Do not use water, as this results in rot. Do not tape insects to paper or send them loose in an envelope.

Place live insects in a container with enough plant material to feed them during transit. Be sure to write "live" on the outside of the container.

UNIVERSITY of GUELPH LABORATORY SERVICES

95 Stone Road West
Guelph, ON N1H 8J7
Tel: (519) 767-6256
Fax: (519) 767-6240
Web: www.uoguelph.ca/pdc

Pest Diagnostic Clinic

SAMPLE SUBMISSION FORM

LABORATORY USE ONLY: LS Form: SubP01/04/03 Pg. 1 of 1

Rec'd: By:_____ **Date Received:** _____

Delivered By: ☐ **Mail** ☐ **Courier** ☐ **In-Person**

LS Sample No: _____ **to** _____

Payment Rec'd: $_____ **Receipt #:**_____

Submitted By:			Owner (if different from submitter):		
Business Name (if applicable):			Business Name (if applicable):		
Street:			Street:		
City:	Prov:	Postal Code:	City:	Prov:	Postal Code:
Tel: ( ) -	Fax: ( ) -		Tel: ( ) -	Fax: ( ) -	
Email:			Email:		

Unless otherwise indicated, report and invoice will be sent to submitter

Report to: ☐ Submitter ☐ Owner Required Report Format: ☐ Fax ☐ E-Mail ☐ Mail

Invoice to: ☐ Submitter ☐ Owner Quotation #: _____ Purchase Order / U of G G/L code:_____

Services Required: ☐ Nematode Count ☐ Nematode Count from Roots ☐ SCN Cyst & Egg Count
☐ Plant Disease Diagnosis ☐ Insect Identification ☐ Plant Identification ☐ Verticillium Count

Plant or Host Affected:	Cultivar/Variety:	Grower/Field sample #:
	Location of Plant (i.e. greenhouse, field, orchard, garden, etc.):	

Size of Planting:	% of Plants Affected:	Symptoms First Appeared in Past: ☐ Days ☐ Weeks ☐ Months ☐ Years	Degree of Injury: ☐ Severe ☐ Moderate ☐ Light
Cropping History:		Future Crop:	

Describe the problem in detail (i.e. symptoms, plant parts affected, distribution of symptoms):

Were chemicals applied? Please specify type of product(s) used and date(s) of application:

Additional comments and specific requests:

Additional Sheet(s) Attached: ☐

Appendix C. Other Contacts

AGRICULTURE & AGRI-FOOD CANADA RESEARCH CENTRES

www.agr.gc.ca/index_e.php

Greenhouse and Processing Crops Centre

2585 County Road 20
Harrow, ON N0R 1G0
Tel: 519-738-2251

Southern Crop Protection and Food Research Centre

1391 Sandford Street
London, ON N5V 4T3
Tel: 519-457-1470

Delhi Research Farm

Box 186 Schafer Road
Delhi, ON N4B 2W9
Tel: 519-582-1950

Vineland Research Farm

4902 Victoria Avenue North
Vineland, ON L0R 2E0
Tel: 905-562-4113

CANADIAN FOOD INSPECTION AGENCY REGIONAL OFFICES (PLANT PROTECTION)

www.inspection.gc.ca/english/toce.shtml

Belleville

345 College Street East
Belleville, ON K8N 5S7
Tel: 613-969-3333

Brantford

625 Park Road North, Suite 6
Brantford, ON N3T 5P9
Tel: 519-753-3478

Hamilton

709 Main Street West, Suite 101
Hamilton, ON L8S 1A2
Tel: 905-572-2201

London

19-100 Commissioners Road East
London, ON N5Z 4R3
Tel: 519-691-1300

Ottawa District

38 Auriga Drive, Unit 8
Ottawa, ON K2E 8A5
Tel: 613-274-7374, ext. 221

St. Catharines

395 Ontario Street, Box 19
St. Catharines, ON L2N 7N6
Tel: 905-937-8232

Toronto

1124 Finch Avenue West, Unit 2
Downsview, ON M3J 2E2
Tel: 416-665-5055

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www.uoguelph.ca

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Alfred, ON K0B 1A0
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Fax: 613-258-8384
www.kemptvillec.uoguelph.ca

Ridgetown Campus

Ridgetown, ON N0P 2C0
Tel: 519-674-1500
www.ridgetownc.on.ca

Department of Plant Agriculture

www.plant.uoguelph.ca

Department of Plant Agriculture, Guelph

50 Stone Road West
Guelph, ON N1G 2WI
Tel: 519-824-4120, ext. 56083
Fax: 519-763-8933

Department of Plant Agriculture, Simcoe

1283 Blueline Road, Box 587
Simcoe, ON N3Y 4N5
Tel: 519-426-7127
Fax: 519-426-1225

Department of Plant Agriculture, Vineland

Box 7000, 4890 Victoria Avenue North
Vineland Station, ON L0R 2E0
Tel: 905-562-4141
Fax: 905-562-3413

Lab Services Division

www.uoguelph.ca/labserv
P.O. Box 3650, 95 Stone Road West
Guelph, ON N1H 8J7
Tel: 519-767-6299
Fax: 519-767-6240

Trace Organics and Pesticides

Tel: 519-767-6485
Fax: 519-767-6240

Pest Diagnostic Clinic

Tel: 519-767-6256
Fax: 519-767-6240

VINELAND RESEARCH AND INNOVATION CENTRE

4890 Victoria Avenue North
Vineland Station, ON L0R 2E0
Tel: 905-562-0320
Fax: 905-562-0084
www.vinelandontario.ca

Appendix D. Pesticide Groups Based on Sites of Action

Insecticides and Miticides

The classification scheme listed below is adapted from information developed by the Insecticide Resistance Action Committee Mode of Action Working Group. Products with the same group number have a similar mode of action. For details on this classification system, see www.irac-online.org/wp-content/uploads/2009/09/MoA-classification_v6.3.3_28july09.pdf.

Group #	Primary Site of Action	Group Name	Product Name(s)
1B	Acetylcholinesterase inhibitor Nerve action	organophosphate	DDVP 20% EC, Diazinon 500 EC, Dibrom, Malathion 25W, Malathion 85E
2A	GABA-gated chloride channel agonists Nerve action	chlorinated cyclodienes	Thionex 50 W, Thionex EC
3	Sodium channel modulators Nerve action	pyrethroids, pyrethrins	Ambush 50 EC, Matador 120 EC, Pounce 384 EC
4	Nicotinic acetylcholine receptor agonists Nerve action	neonicotinoids	Intercept 60 WP, Tristar 70 WSP
6	Chloride channel activators Nerve and muscle action	avermectins	Avid 1.9 % EC
7C	Juvenile hormone mimics Growth regulation	pyriproxyfen	Distance
9B	Selective homopteran feeding blockers	pymetrozine	Endeavor 50WG
11	Microbial disruptors of insect midgut membranes	*Bacillus thuringiensis*	Bioprotec 3P, Bioprotec CAF, DiPel 2X DF, DiPel WP, Foray 48BA, VectoBac 600L

Insecticides and Miticides *continued*

Group #	Primary Site of Action	Group Name	Product Name(s)
12B	Inhibitors of mitochondrial ATP synthase Energy metabolism	organotin miticides	Vendex 50 WP
17	Moulting disruptor Growth regulation	cyromazine	Citation 75 WP
18	Ecdysone receptor agonists	diacylhydrazine	Confirm 240F
21A	Mitochondrial complex 1 electron transport inhibitors (METI) Energy metabolism	METI insecticides and acaricides	DynoMite 75 WP
23	Inhibitors of acetyl CoA carboxylase Lipid synthesis, growth regulation	tetronic and tetramic acid derivatives	Forbid 240 SC
Un	Compounds of unknown or uncertain mode of action[1]	bifenazate	Floramite SC

[1] A compound with an unknown mode of action or where consensus does not exist on mode of action or an unknown mode of toxicity will be held in category "un" until evidence becomes available to enable that compound to be assigned to a more appropriate mode of action class

Fungicides

This classification scheme is adapted from information developed by the Fungicide Resistance Action Committee to distinguish fungicide groups according to their cross-resistance behaviour. M = multi-site inhibitor, U = unknown mode of action and unknown resistance risk, NC = not classified. For further details on this classification system, see www.frac.info/frac/publication/anhang/FRAC_Code_List_2010.pdf.

Group #	Primary Site of Action	Group Name	Product Name(s)	Risk of Developing Resistance
2	Cell division, DNA & RNA synthesis & metabolism	dicarboximides	Rovral 50 WP	Medium to high
3	C14- demethylase in sterol biosynthesis	DMI (De-Methylation Inhibitor) fungicides	Nova 40 W	Medium
4	RNA synthesis	PA (PhenylAmide) fungicides	Ridomil Gold 480 EC or Ridomil Gold 480 SL	High
7	Fungal respiration — complex II: succinate dehydrogenase	SDHI (succinate dehydrogenase inhibitors)	Pristine WG (boscalid = 7 + pyraclostrobin = 11)	Medium to high
9	Methionine biosynthesis (proposed)	Anilino-Pyrimidines	Scala SC	Medium
11	Fungal respiration — complex III: cytochrome bc1	QoI (Quinone outside Inhibitor) fungicides	Pristine WG (boscalid = 7 + pyraclostrobin = 11)	High
14	Lipid peroxidation (proposed)	aromatic hydrocarbons	Botran 75W	Low to medium
17	3-keto reductase, C4 demethylation	hydroxyanilides	Decree	Low to medium
28	Cell membrane permeability, fatty acids (proposed)	carbamates	Previcur N	Low to medium
40	Phospholipid biosynthesis and cell wall deposition (proposed)	carboxylic acid amides	Revus	Low to medium

Fungicides *continued*

Group #	Primary Site of Action	Group Name	Product Name(s)	Risk of Developing Resistance
44	Microbial disrupters of pathogen cell membranes	microbial (*Bacillus* sp.)	Biprotec, DiPel, Rhapsody	Low
M1	Multi-site contact activity	inorganic	Copper Spray Fungicide	Low
M2	Multi-site contact activity	inorganic	Kumulus DF, Microthiol Disperss, Sulphur (Bartlett's Microscopic Sulphur 92%)	Low
M3	Multi-site contact activity	dithiocarbamates	Manzate Pro-Stick	Low
M4	Multi-site contact activity	pthalalimides	Maestro 80 DF, Supra Captan 80 WDG	Low
NC	Unknown	diverse	MilStop	Unknown

Appendix E. Ontario Ministry of Environment — Regional Contact Information

Region/County	Address	Telephone/Fax
Central Region Toronto, Halton, Peel, York, Durham, Muskoka, Simcoe	5775 Yonge Street 8th Floor Toronto, ON M2M 4J1	Tel: 416-326-6700 Toll-Free: 1-800-810-8048 Fax: 416-325-6345
West-Central Region Haldimand, Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Ontario Government Building 119 King Street West 12th Floor Hamilton, ON L8P 4Y7	Tel: 905-521-7640 Toll-Free: 1-800-668-4557 Fax: 905-521-7820
Eastern Region Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/Dundas & Glengarry, Haliburton, Peterborough, Kawartha Lakes, Northumberland, Renfrew, Ottawa, Lanark, District of Nipissing (Twp. of South Algonquin)	1259 Gardiners Road Unit 3 PO Box 22032 Kingston, ON K7M 8S5	Tel: 613-549-4000 Toll-Free: 1-800-267-0974 Fax: 613-548-6908
Southwestern Region Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth	733 Exeter Road London, ON N6E 1L3	Tel: 519-873-5000 Toll-Free: 1-800-265-7672 Fax: 519-873-5020
Northern Region (East) Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma (East), Timiskaming, Sault Ste. Marie	199 Larch Street Suite 1201 Sudbury, ON P3E 5P9	Tel: 705-564-3237 Toll-Free: 1-800-890-8516 Fax: 705-564-4180
Northern Region (West) Algoma (West), Cochrane, Kenora, Rainy River, Timmins, Thunder Bay	435 James Street South Suite 331 Thunder Bay, ON P7E 6S7	Tel: 807-475-1205 Toll-Free: 1-800-875-7772 Fax: 807-475-1745
Standards Development Branch	Pesticides Section 40 St. Clair Avenue West 7th Floor Toronto, ON M4V 1L5	Tel: 416-327-5519 Fax: 416-327-2936
Approvals Branch	Pesticides Licensing 2 St. Clair Avenue West 12A Floor Toronto, ON M4V 1L5	Tel: 416-314-8001 Toll-Free: 1-800-461-6290 Fax: 416-314-8452

Appendix F. The Metric System

Metric Units

Linear Measures (length)		
10 millimetres (mm)	=	1 centimetre (cm)
100 centimetres (cm)	=	1 metre (m)
1,000 metres (m)	=	1 kilometre (km)
Square Measures (area)		
100 m x 100 m = 10,000 square metres (m^2)	=	1 hectare (ha)
100 hectares (ha)	=	1 square kilometre (km^2)
Cubic Measures (volume)		
Dry Measure		
1,000 cubic millimetres (mm^3)	=	1 cubic centimetre (cm^3)
1,000,000 cubic centimetres (cm^3)	=	1 cubic metre (m^3)
Liquid Measure		
1,000 millilitres (mL)	=	1 litre (L)
100 litres (L)	=	1 hectolitre (hL)

Weight-Volume Equivalents (for water)			
1 gram (g) = 0.001 kilograms (kg)	=	1 millilitre (mL)	= 0.001 litres (L)
10 grams (g) = 0.01 kilograms (kg)	=	10 millilitres (mL)	= 0.01 litres (L)
100 grams (g) = 0.10 kilograms (kg)	=	100 millilitres (mL)	= 0.10 litres (L)
500 grams (g) = 0.50 kilograms (kg)	=	500 millilitres (mL)	= 0.50 litres (L)
1,000 grams (g) = 1.00 kilogram (kg)	=	1,000 millilitres (mL)	= 1.00 litre (L)

Weight Measures		
1,000 milligrams (mg)	=	1 gram (g)
1,000 grams (g)	=	1 kilogram (kg)
1,000 kilograms (kg)	=	1 tonne (t)
1 milligram/kilogram (mg/kg)	=	1 part per million (ppm)
Dry–Liquid Equivalents		
1 cubic centimetre (cm^3)	=	1 millilitre (mL)
1 cubic metre (m^3)	=	1,000 litres (L)

Metric Conversions		
5 millilitres (mL)	=	1 teaspoon (tsp)
15 millilitres (mL)	=	1 tablespoon (tbsp)
28.5 millilitres (mL)	=	1 fluid ounce (fl oz)

Application Rate Conversions

Metric to Imperial (approximate)		
millilitres per hectare (mL/ha) x 0.015	=	fluid ounces per acre (fl oz/ac)
litres per hectare (L/ha) x 0.71	=	pints per acre (pt/ac)
litres per hectare (L/ha) x 0.36	=	quarts per acre (qt/ac)
litres per hectare (L/ha) x 0.09	=	gallons per acre (gal/ac)
grams per hectare (g/ha) x 0.015	=	ounces per acre (oz/ac)
kilograms per hectare (kg/ha) x 0.89	=	pounds per acre (lb/ac)
tonnes per hectare x (t/ha) 0.45	=	tons per acre (T/ac)
Imperial to Metric (approximate)		
fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
pints per acre x 1.4	=	litres per hectare (L/ha)
quarts per acre x 2.8	=	litres per hectare (L/ha)
gallons per acre x 11.23	=	litres per hectare (L/ha)
ounces per acre x 70	=	grams per hectare (g/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)

Liquid Equivalents (approximate)		
Litres/Hectare		*Gallons/Acre*
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

Dry Weight Equivalents (approximate)		
Grams/Hectare		***Ounces/Acre***
100	=	1 ½
200	=	3
300	=	4 ¼
500	=	7
700	=	10
Kilograms/Hectare		***Pounds/Acre***
1.10	=	1
1.50	=	1 ¼
2.00	=	1 ¾
2.50	=	2 ¼
3.25	=	3
4.00	=	3 ½
5.00	=	4 ½
6.00	=	5 ¼
7.50	=	6 ¾
9.00	=	8
11.00	=	10
13.00	=	11 ½
15.00	=	13 ½

Conversion Tables — Metric to Imperial

Length		
1 millimetre (mm)	=	0.04 inches (in.)
1 centimetre (cm)	=	0.40 inches (in.)
1 metre (m)	=	39.40 inches (in.)
1 metre (m)	=	3.28 feet (ft)
1 metre (m)	=	1.09 yards (yd)
1 kilometre (km)	=	0.62 mile (mi)
Area		
1 square centimetre (cm^2)	=	0.16 square inches (sq in.)
1 square metre (m^2)	=	10.77 square feet (sq ft)
1 square metre (m^2)	=	1.20 square yards (sq yd)
1 square kilometre (km^2)	=	0.39 square mile (sq mi)
1 hectare (ha)	=	107,636 square feet (sq ft)
1 hectare (ha)	=	2.5 acres (ac)
Volume (dry)		
1 cubic centimetre (cm^3)	=	0.061 cubic inches (cu ft)
1 cubic metre (m^3)	=	35.31 cubic feet (cu ft)
1 cubic metre (m^3)	=	1.31 cubic yards (cu yd)
1,000 cubic metres (m^3)	=	0.81 acre-foot (ac ft)
1 hectolitre (hL)	=	2.8 bushels (bu)
Volume (liquid)		
1 millilitre (mL)	=	0.035 fluid ounces (fl oz)
1 litre (L)	=	1.76 pints (pt)
1 litre (L)	=	0.88 quarts (qt)
1 litre (L)	=	0.22 gallons (Imp.) (gal)
1 litre (L)	=	0.26 gallons (U.S.) (gal)
Weight		
1 gram (g)	=	0.035 ounces (oz)
1 kilogram (kg)	=	2.21 pounds (lb)
1 tonne (t)	=	2,205 pounds (lb)
1 tonne (t)	=	1.10 short tons
Pressure		
1 kilopascal (kPa)	=	0.15 pounds per square inch (psi)
Speed		
1 metre per second (m/s)	=	3.28 feet per second (ft/sec)
1 metre per second (m/s)	=	2.24 miles per hour (mph)
1 kilometre per hour (km/h)	=	0.62 miles per hour (mph)
Temperature		
°F	=	(°C × 9/5) + 32

Handy Metric Conversion Factor

litres per hectare x 0.4 = litres per acre

kilograms per hectare x 0.4 = kilograms per acre

Conversion Tables — Imperial to Metric

Length		
1 inch (in.)	=	2.54 centimetres (cm)
1 foot (ft)	=	0.30 metres (m)
1 yard (yd)	=	0.91 metres (m)
1 mile (mi)	=	1.61 kilometres (km)
Area		
1 square foot (sq ft)	=	0.09 square metres (m^2)
1 square yard (sq yd)	=	0.84 square metres (m^2)
1 acre (ac)	=	0.40 hectares (ha)
Volume (dry)		
1 cubic yard (cu yd)	=	0.76 cubic metres (m^3)
1 bushel (bu)	=	36.37 litres (L)
Volume (liquid)		
1 fluid ounce (Imp.) (fl oz)	=	28.41 millilitres (mL)
1 pint (Imp.) (pt)	=	0.57 litres (L)
1 gallon (Imp.) (gal)	=	4.55 liters (L)
1 gallon (U.S.) (gal)	=	3.79 litres (L)
Weight		
1 ounce (oz)	=	28.35 grams (g)
1 pound (lb)	=	453.6 grams (g)
1 ton (T)	=	0.91 tonnes (t)
Pressure		
1 pound per square inch (psi)	=	6.90 kilopascals (kPa)
Temperature		
°C	=	(°F – 32) x 5/9

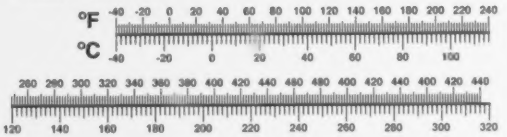
Abbreviations

%	=	per cent (by weight)	km	=	kilometre
a	=	active ingredient	km/h	=	kilometres per hour
AP	=	agricultural powder	kPa	=	kilopascal
cm	=	centimetre	L	=	litre
cm^2	=	square centimetre	m	=	metre
DG	=	dispersible granular	m^2	=	square metre
DP	=	dispersible powder	mL	=	millilitre
E	=	emulsifiable	mm	=	millimetre
EC	=	emulsifiable concentrate	m/s	=	metres per second
e.g.	=	for example	SC	=	sprayable concentrate
F	=	flowable	SP	=	soluble powder
g	=	gram	t	=	tonne
Gr	=	granules, granular	W	=	wettable (powder)
ha	=	hectare	WDG	=	water dispersible granular
kg	=	kilogram	WP	=	wettable powder

Calculating Parts per Million (ppm)

1 ppm	=	1 g active ingredient per 1,000 L water

TEMPERATURE



For exact values the formula is:
Fahrenheit to Celsius: subtract 32 from number of °F, then multiply by 5/9.
Celsius to Fahrenheit multiply °C by 9/5 then add 32.

Emergency and First-Aid Procedures for Pesticide Poisoning

For a major spill, a theft or a fire involving a pesticide, call the Ministry of the Environment at **1-800-268-6060.**

For pesticide poisonings and pesticide injuries, call the Poison Information Centre:

Toronto	1-800-268-9017
Hearing Assistance (TTY)	1-877-750-2233

PREVENT ACCIDENTS

- **Read the label.** Follow all the precautions the label recommends. Read the First Aid section of the label BEFORE you begin to handle any pesticide.
- **Make sure that someone knows** what pesticides you are working with and where you are.
- **Keep a file of labels and product Material Safety Data Sheets (MSDS) for the pesticides you use.**
  Make sure everyone knows where to find this in case of an emergency.
- **Post emergency numbers near all telephones.**
- **Keep clean water, paper towels, extra gloves and clean coveralls close by** in case you spill pesticide on yourself.

If someone has been working with pesticides and you see any possible symptoms of pesticide poisoning or injury, take emergency action immediately.

IF AN ACCIDENT OR POISONING HAPPENS

- Protect yourself from injury first.
- Stop the exposure to the pesticide. Move the victim away from the contaminated area.
- Check the four basic facts — identify the pesticide, the quantity, the route of entry and time of exposure.
- Call an ambulance or the Poison Information Centre.
- Start first aid. This is not a substitute for professional medical help.
- **Provide the label, MSDS sheet or container to emergency personnel** at the scene — or take it with you to the hospital. Do not transport pesticide containers in the passenger compartment of the vehicle.

FIRST AID

If a pesticide comes in contact with skin:

- remove all contaminated clothing; wash skin thoroughly with lots of soap and warm water
- dry skin well and cover with clean clothing or other clean material.

If pesticide comes in contact with eyes:

- hold eyelids open; wash the eyes with clean running water for 15 minutes or more.

If pesticide was inhaled:

- move the victim to fresh air and loosen tight clothing
- give artificial respiration if the victim is not breathing.

Do not breathe in the exhaled air from the victim — you could also be poisoned.

If a pesticide was swallowed:

- **call the Poison Information Centre IMMEDIATELY.**

Emergency numbers are listed at the front of each Bell telephone directory.

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- online at www.serviceontario.ca/publications
- by phone through the ServiceOntario Contact Centre, Monday to Friday, 8:30 AM to 5:00 PM ET
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  - 416-326-3408 (TTY)
  - 1-800-668-9938, toll-free across Canada
  - 1-800-368-7095 (TTY), toll-free across Ontario
- in person at ServiceOntario Centres across Ontario

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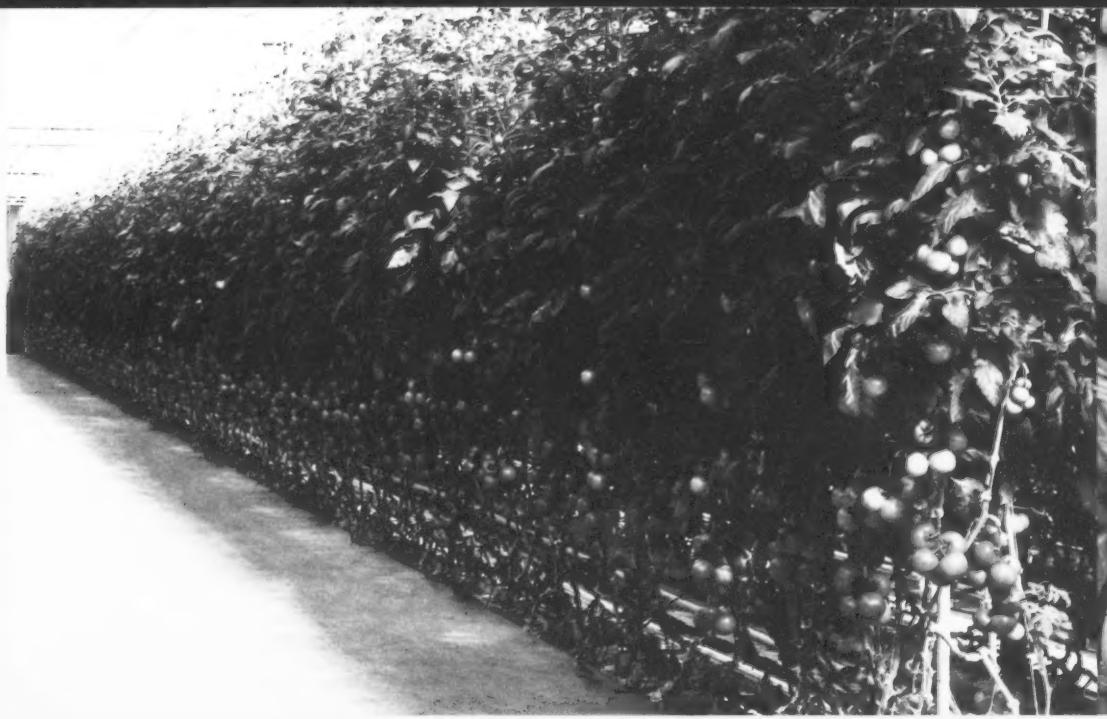

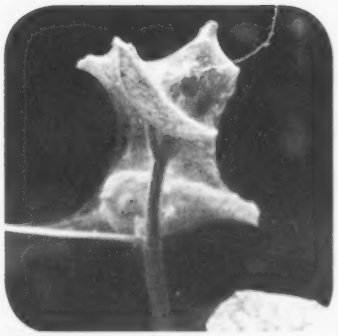

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